A MEASURE OF METER CONSERVATION IN MUSIC, BASED ON PIAGET'S THEORY

By

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A DISSERTATION PRESENTED TO THE GRADUATE COUNCIL OF
THE UNIVERSITY OF FLORIDA
IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE
DEGREE OF DOCTOR OF PHILOSOPHY

UNIVERSITY OF FLORIDA

1975

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ACKNOWLEDGEMENTS

I wish to thank several people who have helped me throughout the conduct of this study. I am particularly indebted to my supervisory committee for their continued encouragement, inspiration, and expertise. I would especially like to thank Dr. Jacquelin Goldman for helping me to gain the insights into Piagetian theory that have served as the basis of this study. I would also like to thank Dr. Phyllis Dorman, whose help made it possible for me to clarify the applications to musical development. Finally, I owe inestimable thanks to Dr. William Hedges, chairman of the supervisory committee, for helping me to synthesize many difficult ideas and give them the necessary focus in this study. His help at every step in the research is gratefully acknowledged.

In addition, I wish to thank Dr. William Ware, who offered many valuable suggestions regarding the study, and Mr. Edward Troupin, who assisted with the preparation of musical materials.

I also wish to thank P. K. Yonge School, Kirby Smith School, and Bent Twig Day Care Center for their participation in this study. The fine cooperation of the faculty and students of these schools made the research possible. In

addition, I would like to thank Ms. Linda Wagner, my research assistant, for an uncommon carefulness and attention to detail in the data collection.

Grateful acknowledgement is given to the Florida Educational Research and Development Council for the financial support of this research. The generosity of the Council's grant is greatly appreciated.

Finally, several friends contributed their support and encouragement when I most needed it. I would especially like to thank Madlyn Levine, Kate Gallagher, and Michael Hanes.

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Abstract of Dissertation Presented to the
Graduate Council of the
University of Florida in Partial Fulfillment of the
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December, 1975

Chairman: William D. Hedges
Major Department: Curriculum and Instruction

The purposes of this study were 1) to develop a task designed to measure conservation of meter in children ages four to nine years, and 2) to test the validity of the measure in terms of Piaget's principle of conservation. The main assumption of the study was that the Conservation of Meter Task could tentatively be considered valid if the following hypotheses, predicted from Piagetian theory, were supported: 1) Success on the task is positively related to age. 2) Success on the task is positively related to success on conservation tasks involving physical properties (e.g., space, number, substance, etc.). 3) Improvement in performance on the task is resistant to training for children at the preoperational level. The procedures of the study involved the following: Children ages four,

five, seven, and nine years were pretested on the Conservation of Meter Task, and on Piagetian tasks of conservation of space, number, substance, continuous quantity, weight, and discontinuous quantity. Subjects who scored as nonconservers of meter were divided into two groups--those who received training in conservation of meter and those who received no training. Following training, subjects were posttested on the same measures used in the pretest. The data were analyzed using multiple regression analysis and analysis of variance. The results of the study tentatively supported all three of the hypotheses, and the Conservation of Meter Task was considered validated.

CHAPTER ONE
INTRODUCTION

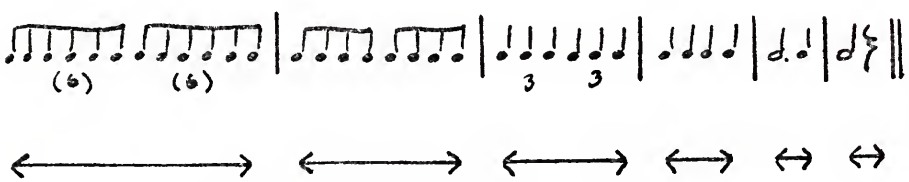
In recent years, there has been increased interest in applying research and theory from developmental psychology to the arts. The graphic arts and music have been the primary focus of these attempts, and Piaget's theory of cognitive development, perhaps because it weds human development and epistemology, has thus far offered the most fruitful applications. The present study was concerned with one aspect of the development of musical thought--how the mind perceives and organizes meter and rhythm in music. Piaget's theory was chosen as the framework for investigating this area because one of the general theses to emerge from his work is that certain aspects of intelligence are operative irrespective of the content of thought. Piaget's work has, for example, uncovered commonalities in child thought on the topics of space, time, number, language, logic, and other areas. The assumption on which this study was based is that those cognitive operations which are common to the physical, visual, and verbal domains of thought should also be observable in the musical/aural sphere. This study attempted to apply one aspect of Piaget's theory--the

principle of conservation--to the perception of rhythm and meter. The purpose of the study was to develop and validate a conservation of meter task which represents a musical analogue of the well known Piagetian tasks in conservation of substance, number, weight, etc.

Conservation of meter may be described as the awareness of a steady musical pulse concommitant with changes in rhythmic pattern. Since music is a temporal art, the relationship between meter (the constant time intervals) and rhythm (the variable organization of sounds within those time intervals) is one that seems so necessary and so obvious that it is largely taken for granted by most musicians. A rhythmic pattern is, after all, merely a succession of a certain number of sounds, each of the sounds having a particular duration. Inasmuch as these rhythms tend to be grouped by the mind into patterns, and to take on accents or points of stress, the patterns give rise to meter--stresses that delineate the equal intervals of time into which rhythmic patterns tend to fall.

In Western music, certain notational conventions--the use of barlines, measures, meter signatures, and metronome markings--attest to the importance of meter as an invariant temporal organizer for a piece of music. Other more obvious examples of the effects of music's inherent meter/rhythm relationship are certain human physical activities--such as marching and some forms of

dancing--where participants move steadily to a regular recurring "beat" irrespective of how "fast" or "slow" are the sounds within the equal time intervals. All musical activities--listening, performing, or composing--involve an experience of the invariance of meter superimposed on variations in rhythm. Composers, for example, may exploit the invariant meter/variable rhythm relationship for the purpose of special effects, as when meter remains the same but a "pseudoritard" is created by increasing the durations and decreasing the number of notes in a measure. The following example is a condensation of the rhythmic changes in 4/4 meter that occur in the last eight measures of Brahms' Rhapsodie (for Piano), Op. 79 No. 2:



The above example is similar to the type of stimulus that was used in the task administered in this study. It is an obvious example of the meter/rhythm relationship exploited for special purposes, although more subtle technical uses of the relationship are everywhere to be found in music. Aside from special effects, however, the meter/rhythm relationship provides in all music the necessary, on-going temporal organization.

The general issue with which this study was concerned is whether the awareness of this seemingly necessary relationship between rhythm and meter is one that results from learning, or is an inherent quality of the way the mind conceives sounds through time, or whether the awareness of this relationship is one that evolves slowly as the result of cognitive development and experience. In other words, the concern here was with whether the construct "conservation of meter" is a valid one. If it were, then it could be expected that Piaget's principle of conservation (and his theory of cognitive development) would be applicable, and the ability to conserve meter would be shown to be a slowly evolving, developmental one, rather than an ability that lies in some inherent quality of the mind, or an ability that is simply the result of learning.

Statement of the Problem

The purposes of the study, then, were as follows:

1. To develop a task designed to measure conservation of meter in children ages 4 to 9 years.
2. To test the validity of the measure in terms of Piaget's principle of conservation.

In accomplishing the purpose of testing the validity of the measure, the following questions were posed:

1. Is success on the Conservation of Meter Task related to age?

2. Is success on the Conservation of Meter Task related to success on tasks of other types of conservation (e.g., substance, number, weight, etc.)?
3. Does training improve performance on the Conservation of Meter Task?

Briefly, the procedures involved in carrying out the above-mentioned purposes were as follows:

1. Children ages 4, 5, 7, and 9 years were pretested on the Conservation of Meter Task, and on Piagetian tasks of conservation of space, number, substance, continuous quantity, weight, and discontinuous quantity.
2. Subjects who scored as "nonconservers" on the Conservation of Meter Task were divided into two groups--those who received training in conservation of meter and a control group (no training).
3. Following training, these subjects were posttested on the same measures used in the pretest (Conservation of Meter Task and Piagetian conservation tasks).

Need for the Study

While the traditional focus in music education research has been on the social, affective, perceptual, and psychomotor responses to music and musical training, little research until recently has been directed toward the cognitive aspects of musical experience. There is a general need to investigate the nature of musical cognition,

and Piaget's theory offers a framework in which to do this.

A few previous studies have, like the present one, attempted to develop music listening tasks that purport to be measures of musical conservation. Primarily these studies have assumed the existence of a music conservation schema (e.g., conservation of melody, conservation of meter, conservation of rhythm, etc.), but have not attempted to empirically validate the construct. As a result, musical conservation tasks vary from study to study, with each new investigator proposing his own without validation of the measure. The present study attempted to respond to the need for a validated measure of conservation of meter, and represents a beginning attempt to develop instruments that will be needed in further research on musical development.

CHAPTER TWO
REVIEW OF RELATED LITERATURE

Investigation into the nature of musical thought is a relatively recent research pursuit. Early attempts in this area have focused on the study of musical abilities and the development of standardized tests of musical aptitude and achievement. What follows is a brief review of some of the rhythm and meter tasks used in these standardized measures.

Aptitude tests purporting to measure rhythmic abilities or perception of "time" have used a wide variety of tasks. The Seashore Measures of Musical Talents (1939) present a "time" test on which the subject indicates whether the second of two successive tones is longer or shorter than the first, and a rhythm test on which the subject indicates whether the second of two short rhythmic patterns is the same as or different from the one preceding it. The Kwalwasser-Dykema Music Tests (1930) utilize very similar items for time and rhythm discrimination, and the Bentley Measures of Musical Ability (1966) contain a "rhythmic memory" test similar to Seashore's rhythm test. The Drake Musical Aptitude Tests (1957) contain items for rhythm in which the subject hears a metronome, with a voice

simultaneously counting the pulses. When the voice and metronome cease, the subject is to continue counting at the same rate, and, when told to stop, to write down the number of pulses he has counted to that point. The Gordon Musical Aptitude Profile (1965) contains a test for meter in which the subject indicates whether the meters of two short melodies are the "same" or "different."

Unlike aptitude tests, achievement tests purport to measure musical abilities that are learned rather than innate, although similar types of items may appear in both types of tests, and there is much controversy over whether the abilities measured by such items are the result of "talent" or achievement. The Colwell Music Achievement Tests (1969), for example, contain items in meter discrimination similar to those on the Gordon Aptitude Profile, except that, given a short melody, the subject must indicate whether the meter is duple or triple.

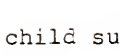
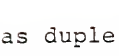
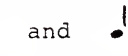
In addition to the items involving rhythm and meter on standardized music tests, other types of individually administered tasks, as described below, have been designed to measure children's musical abilities.

Zimmerman's Studies

The first well-known American study which attempted to apply a Piagetian concept to musical development was done by Marilyn Pflederer Zimmerman (Pflederer, 1963, 1964, 1966b).

She developed nine tasks of musical conservation and individually administered six of the tasks in a pilot study to eight 5-year-olds and eight 8-year-olds. The tasks required the subjects to conserve one aspect of a musical stimulus (recognize that it remained the same), while alterations were made in another aspect (the "foil"). The six tasks were: conservation of meter (with change of durational values), conservation of rhythm (with change of tonal pattern), conservation of melody (with change of durational values), conservation of tonal pattern (with change of pitch level), conservation of tonal pattern (with change of rhythm), and conservation of melody (with change of rhythm and addition of harmonic accompaniment). On all tasks, 8-year-olds gave more correct responses than did 5-year-olds. The results were explained in terms of preoperational and concrete operational thought, with preoperational children tending to center their attention on the perceptual changes, without being able to conserve the stable property.

Of greatest interest for the present study is Pflederer Zimmerman's Conservation of Meter task. Here the subject was presented with a story about "families" of beats in "twos" or "threes." Examples of each were played on a drum, and it was explained to the child that meter remains invariant irrespective of changes in rhythmic subdivisions. Pairs of rhythms were played to the

child such as duple:  and  , and triple: and  , and he was told that both members of each pair were in twos or in threes "because the same amount of time was taken, but some of the notes were shorter and so we could use more in order to take up the time." Following this explanation, the child was presented with short rhythmic patterns played on a drum and tape recorded, and was asked to tell whether these patterns moved in twos or threes. In answering these items, 29% of the responses of 5-year-olds were correct, as compared to 54% of those of 8-year-olds. A second set of items was similar to the first, except that instead of patterns played on a drum, the items were short musical phrases played on a piano. Again 5-year-olds did less well than 8-year-olds, with 44% of responses correct for the former group, and 75% for the latter.

In this same dissertation Pflederer Zimmerman described a task of "Conservation of Meter with One to One Correspondence," but the task was not administered in the study. One to one correspondence here referred to the relationship between the rhythm and words that are chanted representing a "conversation" between two dolls. In the first part of the task, the subject is told that all the correct phrases of the dolls will "move in twos" and that he is to listen to the conversations and identify which doll makes the mistake of not "taking the same

amount of time." Drum rhythms accompany the conversations, for example:

"Johnny" "What is it?" "Come and play."

"Not right now."

The last phrase is wrong because it consumes three beats instead of two. A second set of examples in this task was similar to the first set, except that correct phrases by the dolls must be "in threes" instead of "in twos."

In a later theoretical article, Pflederer (1967) summarized Piaget's work on conservation and reviewed various standardized musical aptitude tests. After discussing what she terms Piaget's "five conservation laws," (combinativity, reversibility, associativity, identity, and tautology and iteration), she proposed her own five laws of musical conservation: 1) identity: the notion that repetitions of a theme are identical to the original; 2) metrical groups: an awareness of the temporal aspects of music, separating meter from rhythm; 3) augmentation and diminution: an increase or decrease in durational values; 4) transposition: change of key; 5) inversion: the substitution of low notes for higher ones and vice versa.

In a second, extended empirical study, Pflederer Zimmerman and Sechrest (1968; Pflederer and Sechrest, 1968a,

1968b; Pflederer, 1966a; Zimmerman, 1970) carried out five experiments involving musical conservation. While all five experiments are of importance, the concern here is primarily with the conservation of meter task that was used in the first experiment.

In Experiment I of this research, tasks similar to those of the previous 1963 study were used to measure conservation of duration (with changes in durational values), of meter (with changes of durational values), of rhythm (with changes of tonal pattern), of melody (with changes of tempo), and of tonal pattern (with changes of pitch and of rhythmic pattern). The six tasks were administered to 80 subjects, 10 boys and 10 girls each at ages 5, 7, 9, and 13 years. Split-half reliabilities for the shorter tasks, I, II, and IV, were low, ranging from .02 to .57, while reliabilities for the longer tasks, III, V, and VI, ranged from .74 to .81. The results of the study showed that, with the exception of Task I which was judged "completely unreliable," the relationship between age and successful responses to the tasks was positive and nearly linear. The authors reported that improvements can be seen at each age level, and that there is thus little evidence of real stages in the Piagetian sense. The exceptions were the two tasks on conservation of tonal pattern, on which there was little improvement after age nine; however, the authors admitted that this may have been due to the limited difficulty of these tasks.

Of greatest concern here are Task I and Task II of this study, Conservation of Duration and Conservation of Meter. The authors claimed that Task I (Duration) is analogous to Piaget's "sausage test" where a ball of plasticene is subdivided into smaller parts. Here two tones of the same pitch were sounded on a piano (and), the second tone was subdivided first into two shorter tones (and), and then into four shorter tones(and), and the subject was asked whether the members of each pair took the same amount of time. Following administration of the task, it was judged to be poorly constructed and unreliable. No age gradient was produced by the task, and if anything, the trend was toward an inverse relationship between age and successful response. The authors concluded that perhaps this was due to the fact that a good score could be obtained simply by agreeing with the examiner, which the younger children would be most likely to do.

Task II, Conservation of Meter, was the same task regarding "families" of beats cited in the previous 1963 study where the subject indicates whether a rhythmic pattern is "in twos" or "in threes." Again scores on the task (computed by the number of correct responses) increased with age. It was pointed out, however, that the rate of improvement on this task was not as great as the rate of improvement on other tasks, most notably Tasks III, V, and VI.

In Experiment II of this research 198 subjects, ages 5, 7, 9, and 13 years, were tested on conservation of melody under deformation of instrument, mode, tempo, harmony, rhythm, contour, and interval. Musical material for the tasks was taken from Bartok's For Children. Subjects were asked to determine whether the stimulus and the "foil" which followed it were the same, different, or both (same in some ways, different in others), with the last being the correct answer. It was found that age was a significant factor in success on the task, and that a short-term training session in conservation of melody did not significantly improve scores over those of the control group.

In Experiment III, a Conservation of Melody task was administered to 141 subjects in grades K, 2, 4, and 8. The task was similar to the one in the preceding experiment except that four familiar songs (rather than Bartok) were used, and were made to undergo changes in instrument, mode, tempo, harmony, rhythm, contour, and transposition. Subjects responded via a key press mechanism which was intended to control for the varying degrees of verbal ability across this age range. Again, age was a significant factor in success on the task, but training, this time a longer-term experience (6 sessions, 20 minutes each) of classroom instruction, was not.

Experiment IV also involved conservation of melody (using the same four familiar songs as before) but with double rather than single deformations (e.g., changes of instrument and tempo, of harmony and rhythm, of mode and contour, etc.). Seventy-one subjects at ages 5, 7, 9, and 13 years responded to the task with the key press mechanism which was tested under two conditions: Condition I called for one key representing the subject's awareness that a variation or deformation was being presented, and another key for the presentation of entirely different music. Condition II called for the subject's pressing a key only when he heard completely different music. On this task, Condition II resulted in higher scores than did Condition I, while no significant age effect was found.

Experiment V tested conservation of tonal pattern (under deformation of rhythm) and conservation of rhythm (under deformation of tonal pattern) through the use of a "paper-and-pencil" instrument rather than an individually administered task. Half of the answer sheets contained visual aids; the other half did not. One hundred and sixty subjects in grades 2,3, 4, and 5 were tested. It was found that each grade significantly improved in performance over that of the previous grade, with a leveling off after grade 4. It was found that visual stimuli aided in performance on the test.

Commentary

The work done by Pflederer Zimmerman, with the help of Sechrest, has made the contribution of drawing attention to the need for studies of cognitive musical development, and to the possibility of applying Piaget's work to aural cognition. This work has, as well, contributed to the development of tasks which are more suitable for young children than the paper-and-pencil methods so often used in studies of musical ability. There are, however, problematic areas in the meter and rhythm tasks.

First, the Conservation of Meter task regarding "families" of beats in twos and threes is more of a discrimination of meter task than one of conservation. The subject's response is not whether the meter remains the same, or changes in some way, but whether it is in twos or in threes. While the manner of presenting the task--an individual administration in story form--is quite different from the aptitude and achievement tests discussed earlier, the actual substance of the task is quite similar to the familiar paper-and-pencil items requiring the subject to indicate whether a meter is duple or triple. While it is true that the items involve changes of rhythm within each measure (so do the more conventional tests), the subject's focus is nevertheless centered on identifying and naming the meter as either duple or triple. In this sense it is more of a discrimination or identification task than

one of conservation and, in fact, the term "discrimination" was used in the author's description of the task. Moreover, measurement of the subject's awareness of the inverse relationship between the number and length of notes in a measure (compensation) is made partially invalid by the fact that, as part of the explanation of the task, the experimenter actually tells the subject that "the same amount of time was taken, but some of the notes were shorter and so we could use more in order to take up the time." This gives the subject, prior to testing, a brief verbal pretraining on the notion of compensation.

The second task described, but not administered to subjects in Pflederer Zimmerman's 1963 study, offers a slightly different problem. Here the task on Conservation of Meter with One to One Correspondence represents a rather questionable analogy to the Piagetian tasks involving one to one correspondence of objects such as eggs and egg cups. On the meter task, the child never directly compares the words to the drum rhythms, as he never hears them singly, but always simultaneously, and the words and drum beats always occur in exactly the same rhythm, with one never faster, slower, or otherwise different from the other. There is thus no reason to believe that a true notion of one to one correspondence is ever utilized by the child. In fact, it is probable that, upon hearing them, the words and drum beats become

so intertwined in the mind of the subject that the same task might just as easily have been administered with the words alone, and not with the drum beat.

Finally, an additional weakness affecting both of these conservation of meter tasks is that correct responses depend on aural memory as well as discrimination or "conservation." Particularly in the task of Conservation of Meter with One to One Correspondence, the subject must remember the pattern he has just heard in the past, in order to compare it to the one he is presently hearing. Especially for young children, the difficulty of relying on aural memory to make comparisons poses a serious threat to the validity of a conservation-type task.

The Conservation of Duration task from the 1968 study has already been discussed as poorly constructed and unreliable, by the authors' admission. An additional weakness of the task (in addition to the problem pointed out by the authors that a correct response is mere agreement with the experimenter) is that, like the meter tasks, accurate aural memory is a prerequisite to correctly responding to the task. It is the temporal quality of music that demands aural memory and which prevents this task from being, as the authors intend, analogous to what they referred to as Piaget's "sausage test." That is, the subject can never directly compare the long single tone (the standard) and the two or four shorter tones (the

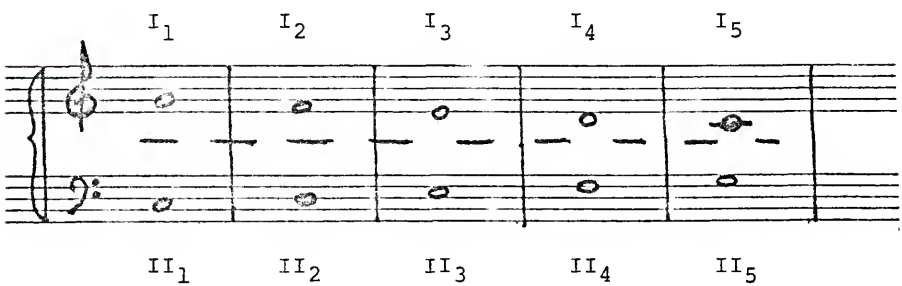
variable stimulus) because they do not exist together, but only in succession. The comparison of the two durations must be made in memory.

Jones' Study

A more recent study which attempted to apply Piagetian principles to the development of the meter concept has been done by R. L. Jones (1971). Jones performed a scalogram analysis on a sequence of eleven musical tasks, beginning with "basic discriminations" of sounds (such as high/low, fast/slow, and long/short) and progressing to the actual "meter concept." Again the meter concept was here defined as the subject's ability to determine whether short fragments "swing" in groups of twos or threes. However, unlike Pflederer Zimmerman, Jones was not concerned with conservation per se, and did not rely on Piaget's study of conservation of weight, number, substance, etc., but rather on his study of the child's conception of time (Piaget, 1969).

For four of his tasks, Jones borrowed from Piaget a task in which the subject manipulates an apparatus consisting of two flasks, one directly above the other, connected by a spigot. At the start of Piaget's experiment, the top flask is filled with water, and the bottom one is empty. The subject makes a drawing of this, and then allows some water to flow from the upper to the lower flask. Successive drawings are made each time the water

is allowed to flow, so that eventually the subject has made a series of drawings representing successive time intervals, during which the top flask is gradually emptied, and the bottom one is filled with water. The task continues, with the experimenter questioning the subject, shuffling the drawings, having the subject re-seriate them, and so on. In the study by Jones, four of the eleven scaled musical tasks (Nos. IV, V, VI, and VII) leading up to the meter concept were directly derived from this experiment by Piaget. In place of the subject's drawings of water flasks, however, Jones presented the subject with a ready-made picture of two staves, the top one bearing a treble clef and five whole notes descending stepwise, the bottom staff bearing a bass clef and five whole notes (directly under the five treble notes), ascending stepwise. (See example below.)



Thus the following analogy was made to Piaget's experiment with the water flasks: at interval 1, the top flask is filled with water, and the bottom one is empty; likewise, where the musical notation is used, the top note is at its highest point, the bottom note at its lowest. At interval 2, the water in the top flask has dropped slightly, while there is now a small amount of water in the lower one. Likewise the note on the top staff has moved down a step, and the bottom note has moved up a step, and so on for five time intervals. Jones made use of this picture of musical notation for his Tasks IV, V, VI, and VII, which, like Piaget's tasks, are intended to measure, respectively, the child's conception of seriation, double seriation, simultaneity, and succession.

Commentary

While Jones' task bears some resemblance to Piaget's, it differs from it by the fact that, in Jones' task, the child has directly witnessed no actual motion, as he has in watching the flow of water, and he has not, through drawing, made his own representation of motion. Jones' task is, in essence, a non-musical one, because the child does not hear the pitches as they descend (in the top staff) or ascend (in the bottom staff). Jones himself admits that having the subject hear the tones was omitted from the experiment only "because of an oversight," but

he maintains that "this does not seem to affect the basic nature of the task" (1971; page 51).

The present experimenter finds it difficult to justify a task as a musical one when no sound is evident. The fact that four such non-musical tasks comprise a major segment of the total scaled sequence (11 tasks) poses a threat to the face validity of the entire sequence. Musical notation is only a visual symbol system; it is not a substitute for music. Jones' subjects were presented in these four tasks with only static pictures. Having not heard the sounds which were represented by the notes, the symbols on paper could not be representative of sounds previously experienced, as was the case with Piaget's experiment, in which the subject's <u>own</u> pictures were symbols of motion previously witnessed. Above all, the important quality in Piaget's experiment which is lacking in Jones' is the notion that time is an abstraction which is always relative to some motion or movement or to a change in or transferral of energy. Thus all motion or energy expenditure is temporal--i.e., measures time or passes through time. In the case of Piaget's experiment, the flow of water from one flask to another is a "clock" which measures off units of time, and the pictures represent this time sequence. In the case of Jones' experiment, the changes in pitch levels could have represented different time intervals, but they were not

heard by the subject. Thus no time intervals were experienced by the subject, and the pictures did not represent a series of events that were witnessed. To this must be added the fact that, while the pictures of water flasks at least look like the actual flasks themselves, symbolic musical notation does not at all "look like" the sounds it represents. Musical notation, for a child, is likely to be relatively unfamiliar and confusing. Even if the subject had heard the sounds and then viewed the musical notation, the problem remains that he is required to engage in the difficult process of translating an aural experience into visual symbols. To Piaget's favor, on the other hand, the experience of witnessing the flow of water in the flasks is a visual/spatial one, and likewise the pictures (symbols) are visual/spatial.

Other Music Conservation Studies

Because of Pflederer Zimmerman's pioneering work in the development of music conservation tasks, a few recent studies have appeared which make use of her tasks as models for the measurement of musical conservation. Primarily these studies have not attempted to validate the tasks, but rather have had as their main purpose the investigation of relationships between music conservation and other factors such as musical experience, age, home environment, etc. Three such studies are briefly described below,

along with a study which assessed the effects of specific training in conservation of melody.

King (1972) developed a Melodic Pattern Conservation Test which makes use of non-Western music in an effort to present a culturally "neutral" stimulus to American subjects. The subjects were asked to conserve 12 melodic pitch patterns in the face of deformation of timbre, pitch, and duration. The study sought relationships between performances on the music conservation test and the following: grade level (1, 5, and 9), social class (lower, middle, upper), social environment (urban, rural), sex, home music environment (using the Wermuth Questionnaire), and prior experience with non-Western music. The results of the study showed that grade level, social class, and social environment contribute to the ability to conserve melodic pitch patterns, while home environment and sex (except for duration items) do not. A plateau in music conservation was found at the fifth grade level. As social class and grade level increased, responses became more consistent and more correct.

Thorn (1973) developed a music conservation task in which melodic and rhythmic patterns were presented twice: first in their "original" form and then with some change in presentation (the "foil"). Thorn tested children ages 7 to 13 years, and noted correlations between scores on the music conservation task and age, degree of participation in music groups, type of private music lessons, and

number of years of lessons. She found that, although music group participation and type of private music lessons affected the child's music conservation, age had the most significant effect. The number of years of private lessons, however, had little effect on the musical conservation scores. She also found (similar to Piaget) three levels in the development of conservation: nonconservation, a transitional stage, and conservation. She concluded that Piaget's theory could be useful in teaching melodic and rhythmic concepts.

Larsen (1973) developed a four-part task of melodic variation, which he believed would require formal operational thought, and administered it to 24 subjects, eight each in grades 3, 5, and 7. The task required subjects to construct a melody by ordering a set of bells to fit a model and to perform variations on the melody. Subjects were also shown visual diagrams of the variation techniques of inversion, retrograde, and retrograde inversion, and asked how valid they felt these methods of variation were. Larsen found it consistent with Piaget's theory that: 1) younger subjects had a more difficult time than older ones in simply ordering a set of pitches; 2) as age increases, so does the awareness of the concept of variation; 3) as age increases, so does the tendency to accept the modifications as "valid" means of varying the original pattern; 4) as age increases, so does the ability to recognize inversion, retrograde, and retrograde inversion from visual diagrams.

A recent study by Botvin (1974) tested the effectiveness of two types of training in improving conservation of melody. "Conservation of melody" in this study was construed as the subject's ability to recognize that a simple melody (in this case a familiar song like "Yankee Doodle" or "Old MacDonald") remains invariant in spite of changes in tempo (both faster and slower than the original). First grade children were pretested in Conservation of Melody, and also in conservation of mass, weight, liquid, and number. Two types of training in conservation of melody were then administered to separate groups of nonconservers:

1. Training that involved behavior-shaping through successive approximation (SA), and
2. Training that involved the above-mentioned technique, with the addition of verbal rule instruction (SA-VRI).

Posttests were administered in conservation of melody and conservation of mass, weight, liquid, and number.

The results of the study indicated that:

1. Both methods of training were equally successful in improving performance on the conservation of melody task.
2. Training in conservation of melody also improved performances on the Piagetian conservation tasks in mass, weight, and number (but not liquid); unexpectedly, the SA training was more successful than the SA-VRI

method in effecting this cross-modal transfer (from the auditory to the visual).

As a result, Botvin made the following conclusions:

1. There is reason to doubt the notion that experimentally-induced conservation is only a pseudoconcept. Subjects can apparently not only be successfully trained in conservation of melody, but there is as well a transfer effect to other types of conservation.
2. Since both musical and non-musical types of conservation appear to be mediated by the same cognitive structures, one may be improved by the other.

Commentary

One difficulty with the conclusion drawn from the apparent success of the training is that there was no definite indication of how permanent or stable were the effects of training in conservation of melody. Depending on the length of time that elapsed between the subjects' training and their posttests, retention time remains in question. Further, the posttest in conservation of melody followed the same format as the pretest; i.e., no additional techniques were used on the posttest, such as probing, attempts at extinction, or countersuggestion by the experimenter, which might have been used to measure the depth of the subject's understanding of conservation. In short, there is no definite proof that true "learning"

of conservation--either of melody or of the physical properties--resulted from the training in conservation of melody.

A second difficulty with the Botvin study is that, like other studies involving musical conservation, there has been no validation of the task used to measure the construct in question. In the present case, the conservation of melody task appears to have face validity, but its validity as a measure of a "true" Piagetian conservation remains in question. Moreover, a re-interpretation of the results of the study could in fact negate the validity of the musical conservation task. If it is assumed, for example, that conservation results from developmental rather than learned abilities, then the fact that successful performance on the conservation of melody task was trainable could mean that the task itself was not actually measuring a "conservation" ability at all. In short, "conservation of melody," as a construct, has not been validated.

Summary of Literature Review

Early attempts to measure the musical abilities of children have focused on the development of standardized tests of music aptitude and achievement. These tests contain a variety of tasks involving meter, most of them requiring the subject to identify meter groupings (duple, triple, etc.).

Pioneer work by Marilyn Pflederer Zimmerman resulted in the application of Piaget's principle of conservation to the development of children's musical concepts. Zimmerman's tasks were designed to measure conservation of meter, as well as conservation of rhythm, melody, tonal pattern, etc. It was found that successful performance on these tasks increased with age.

R. L. Jones developed a different type of meter task, based not on conservation, but rather on Piaget's study of the child's conception of time.

Various studies continued to investigate children's performances on music conservation tasks. These studies corroborated the finding that success on the tasks improves with age. In addition, Botvin has found that training can improve performance on a conservation of melody task and also have a transfer effect on Piagetian conservation tasks.

After reviewing the tasks that have been developed to measure conservation of meter (and conservation in general), it was concluded by the present experimenter that there is a need for the validation of a measure of conservation of meter.

CHAPTER THREE
RESEARCH DESIGN AND METHODOLOGY

Development of the Conservation of Meter Task

For this study a Conservation of Meter Task was developed which presented to young children musical examples in which meter and rhythm were set in strong relief. In each musical example, the regular, invariant recurrence of meter was made obvious by accenting the meter with a continual aural or visual stimulus (a loud non-pitched click or a flash of light), while simultaneously the rhythm underwent obvious changes of either steadily increasing (to more, shorter notes) or decreasing (to fewer, longer notes). It should be pointed out that under normal circumstances, musical activities such as listening or performing do not involve such an obvious focus on the invariance of meter and the variability of rhythm. It is believed by the experimenter, however, that only by making a strong juxtaposition between rhythm and meter, by accenting their qualities and setting them in obvious relief, can the child's grasp of the fundamental nature of meter and rhythm be assessed.

The task developed for the present study was an attempt to remedy some of the problems surrounding the

concept of conservation of meter that have been identified in the review of literature on this topic. The intent was to devise and test a task of meter conservation which conforms to the Piagetian notion of conservation, and yet represents a truly musical and aural phenomenon rather than either a visual or a psychomotor one. The task, then purports to be one of true conservation of meter--not the identification or discrimination of various types of meters (e.g., duple or triple; the ideas of "swinging" or "families" of twos or threes), but the awareness that a meter (of whatever type, whether duple, triple or otherwise) is conserved, i.e., remains constant. The essence of the meter concept proposed here, then, is not the idea of a numerical grouping (e.g., two or three), but the fact that it remains invariant.

It is believed by the present experimenter that this latter definition of meter not only represents a truer type of conservation, but that it also solves one of the difficulties of a meter task which tests for duple vs. triple discrimination--i.e., the problem of cultural bias. It is primarily the music of modern Western cultures which groups meter impulses by twos or threes--a custom not shared by many other cultures, or indeed even other epochs in Western history (Sachs, 1953). Other groupings, such as five or nine for example, are common among so-called primitive cultures, as well as in some of the very recent music of the West. It is hoped that the task used in the

present study, by construing meter as a constant impulse or "beat," however grouped, may have more universal applications and be less susceptible to cultural bias.

In addition, the task of the present study purports to be a more accurate analogue to the Piagetian tasks by embodying the property of compensation, which figures prominently in all conservation tasks. In the conservation of quantity task, for example, where a liquid is poured from a tall, narrow container into a low, shallow one, the decrease in height is compensated for by an increase in width. Likewise, in the conservation of number task, where parallel rows of objects are alternately spread out or condensed, an increase in the length of the row is compensated for by a decrease in density. Various studies (Goodnow, 1973; Curcio, Levine, and Robbins, 1972; Gelman and Weinberg, 1972) have assessed the role of compensation--the awareness of covarying dimensions in a display--in the development of conservation. The task used in the present study attempts to embody the property of compensation by the use of rhythms which undergo compensatory change in a consistent and progressive manner; that is, in each successive measure, rhythms in diminution appear to get "faster" by virtue of the fact that the notes increase in number, but decrease in duration, while rhythms in augmentation appear "slower," as there are fewer, but longer notes per measure. Thus a compensatory relationship

exists between the number and durations of notes comprising the rhythm.

Further, the task attempts to assess conservation of meter with a minimum of reliance on aural memory. The factor of aural memory is one which plagues many musical studies, since the temporal property of music makes it impossible to compare two musical stimuli simultaneously, as can be done with tangible, "before the eye" displays. The task, then, attempts to diminish the subject's reliance on aural memory by not requiring a direct "before and after" comparison of two different stimuli, but rather a continuous attention to a single stimulus.

Finally, the task developed for the present study attempts to diminish the effects of the subject's reliance on a purely aural mode of perception in completing the task. An alternate form of the task serves as a check on the possibility that the measurement of conservation is confounded with aural discrimination. The two forms of the task are: aural/aural (where steady clicks representing meter are heard simultaneously with variable rhythms) and aural/visual (where the same steady meter clicks and variable rhythms are heard, but with the addition of a visual stimulus to reinforce the meter in the form of a light which steadily blinks on and off simultaneously with the meter clicks). Thus, those subjects who fail the aural/aural form of the Conservation of Meter Task are

given the aural/visual form to determine whether their failure resulted from a true lack of conservation (in which case they would fail both forms of the task) or from merely an inability to distinguish aurally between the clicks and the rhythms heard (in which case they should score as conservers on the aural/visual form).

Validation of the Conservation of Meter Task

The procedures used in this study to test the validity of the Conservation of Meter Task conform to certain of the guidelines set forth by the American Psychological Association Committee on Psychological Tests in 1952 and 1954 (Cronbach & Meehl, 1955; Helmstadter, 1964). These procedures involve:

1. Setting forth the hypothesis that the test measures the construct in question;
2. Making predictions from existing theory regarding (among other things) group differences, expected correlations, and changes in performance as a result of experimental manipulation;
3. Securing data which will indicate rejection or non-rejection of the hypothesis.

For the purposes of the present study, the hypothesis was set forth that conservation of meter is a valid construct derived from Piagetian theory, and is measured by the Conservation of Meter Task used in this study.

Further, the assumption was made that the task can tentatively be considered valid if the following hypotheses, predicted from Piagetian theory, were supported:

1. Success on the task is positively related to age.
2. Success on the task is positively related to success on conservation tasks involving physical properties (e.g., space, number, substance, etc.).
3. Improvement in performance on the task is resistant to training for children at the preoperational level.

In relation to the above hypotheses, data were collected to answer the following questions:

Major Questions of the Study

1. a) Are scores on the Conservation of Meter Task related to age?

   b) Is there a significant difference in mean scores on the Conservation of Meter Task among various age groups (4, 5, 7, and 9 years), or between sexes?
2. Are scores on the Conservation of Meter Task related to scores on conservation tasks involving physical properties (e.g., space, number, substance, etc.)?
3. Is improvement in performance on the Conservation of Meter Task resistant to training for preoperational subjects? Specifically, is there a significant difference in mean scores on the Conservation of Meter posttest between trained and untrained subjects, at

the preoperational (or concrete operational) level?

Secondary Questions

4. If a Conservation of Meter Task item is incorrectly answered, is the erroneous response to an item involving diminution more likely to be "faster"? Is the erroneous response to an item involving augmentation more likely to be "slower"? Specifically, is there a significant difference between the number of "faster" and "slower" responses among the incorrect responses given on each of the Conservation of Meter Task items?
5. Are Conservation of Meter Task items involving duple rhythms more difficult than those involving hemiola rhythms? Specifically, is there a significant difference between the number of subjects who correctly answer Conservation of Meter Task items involving duple rhythms and those involving hemiola rhythms?
6. Are Conservation of Meter Task items involving rhythms in diminution more difficult than those involving rhythms in augmentation? Specifically, is there a significant difference between the number of subjects who correctly answer Conservation of Meter Task items involving rhythms in diminution and those involving rhythms in augmentation?
7. For what age group(s) or sex(es), if any, does training improve performance on the Conservation of Meter Task?

Specifically, is there a significant difference in the mean scores on the Conservation of Meter posttest between the trained and untrained subjects, at various age levels (4, 5, 7, and 9 years) and for each sex (male, female)?

Definitions

Meter is here defined as the regular recurrence of accents, at equal time intervals. Rhythmic patterns occurring within these time intervals may vary with respect to the number and duration of sounds comprising the pattern. An inverse relationship exists between the number and duration of notes in the rhythmic pattern; i.e., within a set of equal time intervals or measures (meter), an increase in the number of notes must be compensated for by a decrease in the duration of all or some of the notes, and, conversely, an increase in the duration of the notes must be compensated for by there being fewer of them. Meter, then, remains constant, while rhythmic patterns vary, with the patterns embodying Piaget's notion of compensation (i.e., numbers and durations of sounds vary in an inverse relationship).

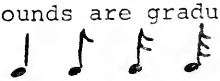
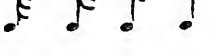
Conservation of meter refers to the understanding that meter is invariant, irrespective of transformations in rhythm. In operational terms, conservation of meter refers to the awareness that the durations of

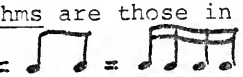
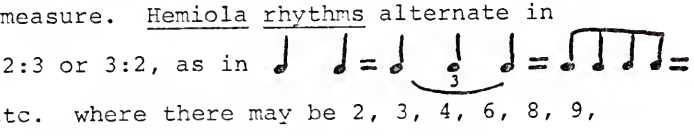
successive measures of music (the time interval between meter impulses) are equal, regardless of the distributions of sounds within the measure. In this context, conservation of meter has nothing to do with the subject's knowledge of the number of "beats" in a measure, or whether the meter is duple or triple.

For the purposes of the present study, a conserver of meter is a subject who correctly responds to at least three of the four items on the Conservation of Meter Task--whether the aural/aural form or the aural/visual form of the task. Thus a subject who fails the aural/aural task (with clicks) may still be designated as a conserver if his performance is satisfactory on the aural/visual task (clicks simultaneous with blinks of light). A nonconserver of meter is a subject who correctly responds to less than three of the four items on the aural/aural task and less than three on the aural/visual task.

An aural/aural task of conservation of meter, which was administered to all subjects, here refers to a task in which sound is the medium for both the variable rhythmic patterns and the steady impulses representing meter (e.g., a loud non-pitched click). An aural/visual task of conservation of meter is one in which the rhythms are again aurally perceived, but the impulses representing meter are both aural and visual (i.e., a flash of light is seen simultaneously with the meter click). The

aural/visual task was administered to those subjects who did not perform as conservers on the aural/aural task. The aural/visual task was used to determine whether failure on the aural/aural task was actually due to nonconservation (in which case there should be no significant difference between scores on both tasks) or due only to the inability to discriminate or distinguish aurally between the meter clicks and the rhythms (in which case the subject should perform as a conserver on the aural/visual task).

Rhythmic diminution here refers to a change in rhythm such that the sounds are gradually subdivided into smaller units (e.g.,  etc.), while more tones are sounded per measure. Rhythmic augmentation is the opposite--an additive process where the length of tones increases, and there are fewer tones per measure (e.g.,  etc.).

Duple rhythms are those in a proportion of 2:1 or 1:2, as in  etc. with 1, 2, 4, 8, 16, etc. notes per measure. Hemiola rhythms alternate in proportions of 2:3 or 3:2, as in  etc. where there may be 2, 3, 4, 6, 8, 9, etc. notes per measure. The four possible types of rhythms used in this study are, then: duple in diminution, duple in augmentation, hemiola in diminution, and hemiola in augmentation.

In addition to the Conservation of Meter Task, Piagetian tasks were administered in conservation of space, number, substance, continuous quantity, weight, and discontinuous quantity. These tasks are scored from 0 to 12 (one point each for judgment and explanation on each of the six tasks). On the basis of these scores, a preoperational subject (or nonconserver) is defined as any subject who achieves a score of three or less on these measures. A conserver or concrete operational subject is one who achieves a score of six or above on these tasks. Subjects who score between these points (a four or five) are considered to be in a transitional stage.

Instrumentation

Four instruments were administered in this study:

1. The Preliminary Vocabulary Test
2. The Conservation of Meter Task
3. The Concept Assessment Kit--Conservation
4. The Draw-A-Man Task.

The instruments were administered by the experimenter and three assistants (undergraduate students in Childhood Education). The order of the tasks varied, with the exception that the Preliminary Vocabulary Test always preceded the Conservation of Meter Task. Otherwise, the order in which the tasks were administered depended on convenience and the subject's attention span, resistance

to fatigue, and so on. If a child became fatigued by the aural/aural form of the Conservation of Meter Task, for example, he was given the Draw-A-Man Task to provide a break in the activity before returning to the aural/visual form of the task. All tasks, however, were completed by a subject in a single session lasting approximately 45 minutes.

Preliminary Vocabulary Test

A Preliminary Vocabulary Test designed by the experimenter was used to screen subjects for knowledge of the words "faster," "slower," and "stays the same," as applied to a sequence of sounds, since these terms are used in the Conservation of Meter Task. In order to control for possible vocabulary difficulties, only children who correctly answered all four items on the vocabulary test were used as subjects for the experiment. All items are prerecorded on tape, with the sounds (clicks) generated from an electric metronome with a rheostat dial.

The subject is given the following explanation of the task:

"You will hear some clicks like these. (Demonstrate by playing tape of eight steady clicks at tempo of MM = 80.) I am going to play some more clicks, and you tell me if the clicks get faster, or slower, or stay the same."

(Play Item 1--Slower. The clicks decrease in tempo from MM = 120 to MM = 60 in 15 seconds. If the subject requested it, the item was repeated, but only once per item.)

"What about the clicks--did they get faster or slower or stay the same?" (The subject's response was recorded on the form. Knowledge of the correctness of the answer was not given. The experimenter continues by saying:)

"Now listen again and tell me if the clicks get faster or slower or stay the same." (The same procedure was followed for the remaining items:)

Item 2: Remains the same. Steady clicks at a tempo of MM = 80 for 15 seconds.

Item 3: Faster. The clicks increase in tempo from MM = 72 to MM = 160 in 15 seconds.

Item 4: Slower. The clicks decrease in tempo from MM = 80 to MM = 40 in 15 seconds.

The order of the experimenter's use of the words "faster," "slower," and "stays the same," was varied randomly with each item.

Conservation of Meter Task (COM)

Aural/Aural Task (COM AA)

The Conservation of Meter Task designed by the experimenter contains four items. For each item, the subject hears eight moderately loud non-pitched impulses (clicks) at a steady tempo (MM = 60) representing meter. The subject is asked whether the clicks "get faster, slower, or stay the same." After the subject asserts that they stay the same, he is asked to listen to a second example in which the same steady meter clicks are heard simultaneously with repeated tones in various rhythms. The subject is then asked whether the clicks "got faster,

slower, or stayed the same." After his response, he is asked: "Why? How can you tell?" The subject is not told to clap his hands, tap feet, etc., but if he does so of his own accord, these behaviors are noted on the scoring form, along with any other behaviors or comments. The subject is not given any knowledge of the rightness or wrongness of his responses.

All items on the Conservation of Meter Task are prerecorded using a SONY reel-to-reel stereo tape recorder. The sounds are generated from a Moog synthesizer, with nonpitched clicks representing meter (left channel) and sine wave pitches on a single tone used in the rhythms (right channel). A different pitch was used in each item to prevent the subject's saturation with a single tone. Both clicks and rhythms are heard at the same level of volume, and a 4/4 meter is used in each item. The procedures result in each item's having only changes in rhythm, while pitch, loudness, and timbre remain the same and are controlled. Thus, the meter/rhythm relationship is exposed without influence from other sound variables.

The explanation of the task is as follows:

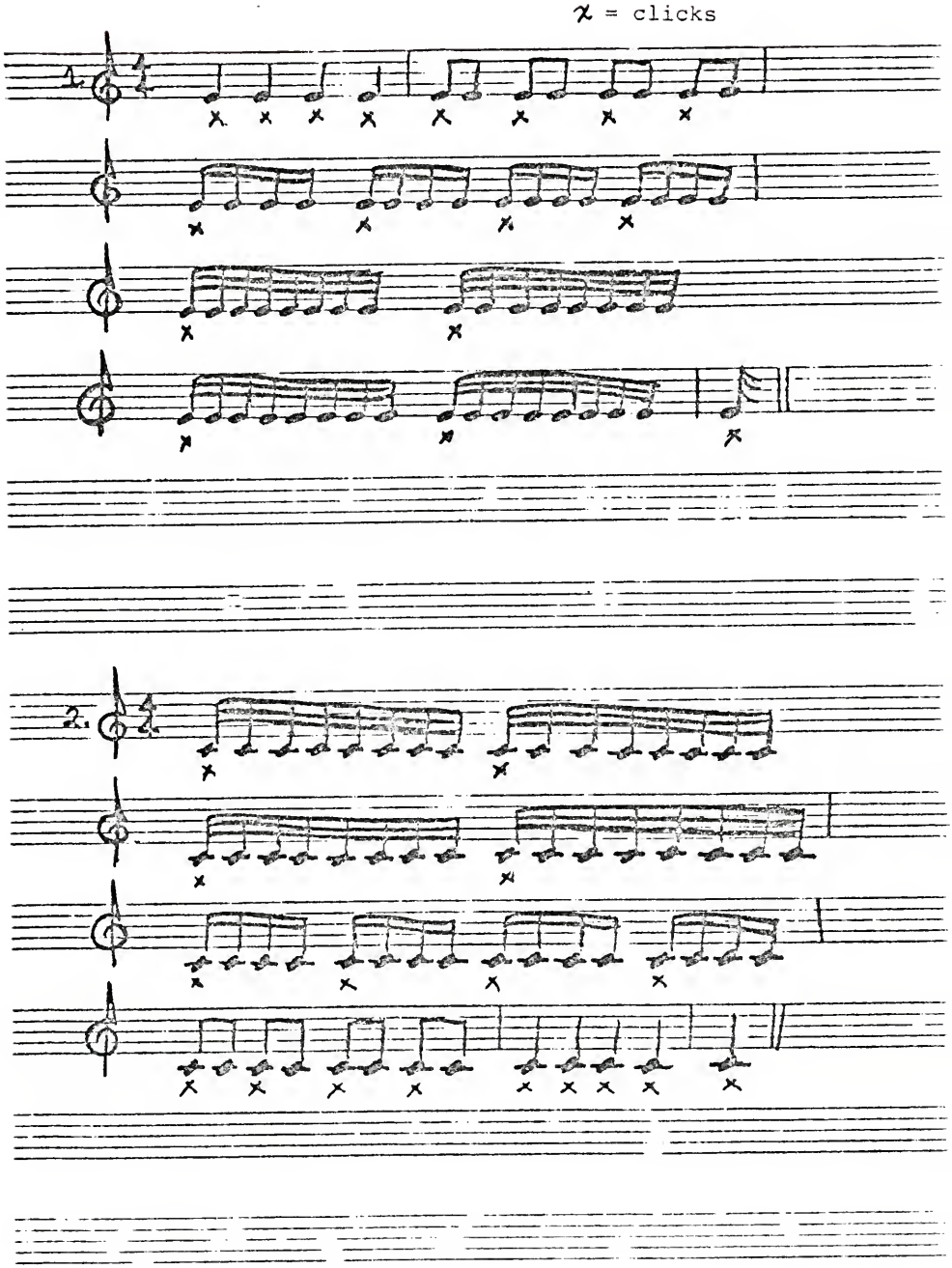
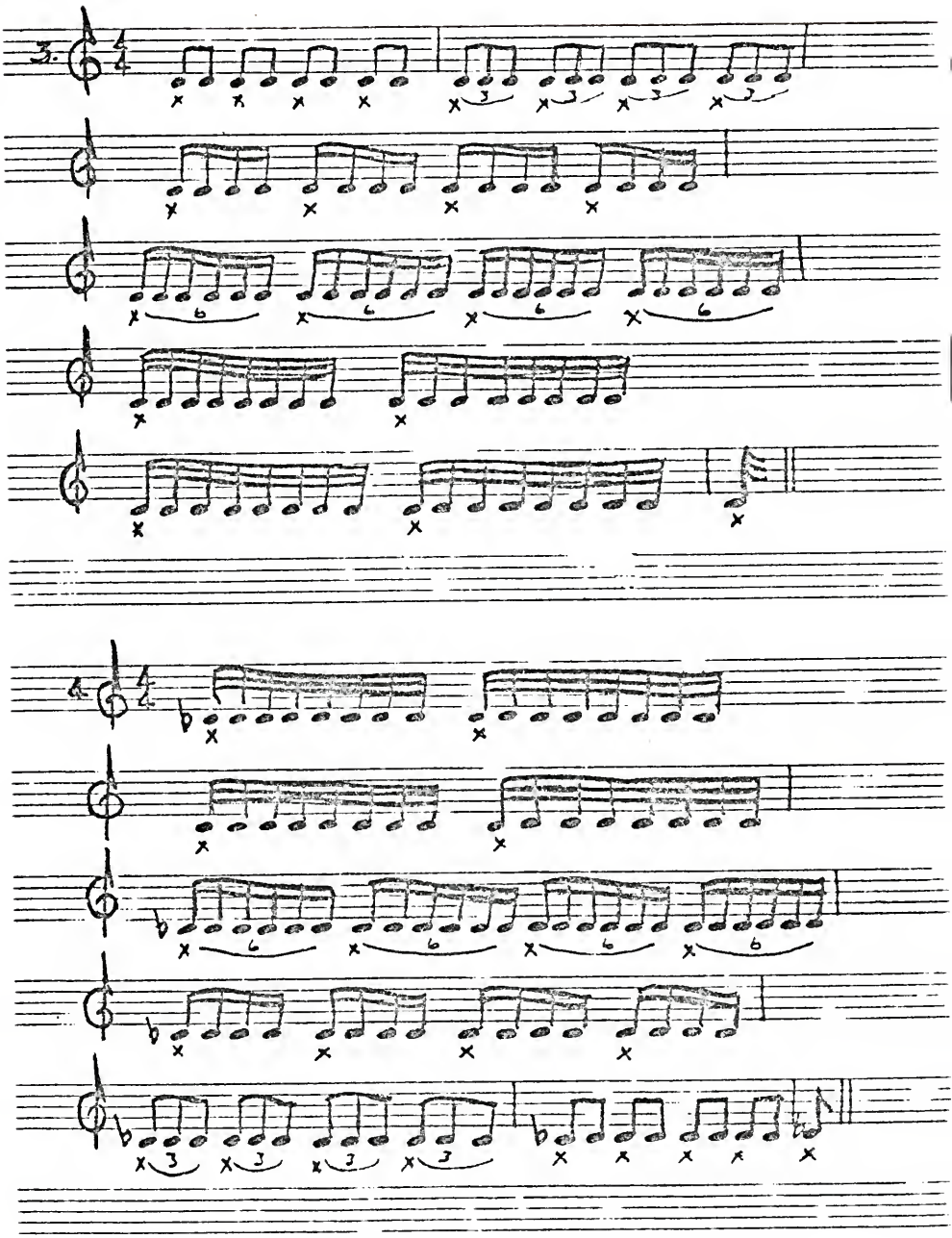
"Now you will hear some clicks again. Tell me if the clicks get faster or slower or stay the same. (Play Item 1, part A, 8 clicks alone.) Did the clicks get faster or slower or stay the same? Now you will hear some clicks and also some other sounds. Listen very carefully to the clicks and tell me if they get faster or slower or stay the same. (Play Item 1, part B, clicks with rhythms.) What about the clicks--did they get faster or slower or stay the same? Why? How can you tell? (Record responses on form.) Okay, now listen again (Item 2). (Same procedure for Items 2, 3, and 4.)"

The following describes the four items: (See musical examples, pages 45 and 46.)

Item 1: Duple rhythms in diminution: While the meter clicks continue at a steady tempo, repeated notes (on e) are heard with one note per click, then two notes per click, four, eight, etc.

Item 2: Duple rhythms in augmentation: The reverse of item 1, where the repeated notes (on c) are heard with sixteen notes per meter click, then eight, four, two, etc.

Item 3: Hemiola rhythms in diminution. Repeated notes (on d) are heard with the following numbers of notes per meter click: two, three, four, six, eight, etc.

Item 4: Hemiola rhythms in augmentation: The reverse of Item 3, with eight, six, four, three, two repeated notes (on d-flat) per meter click.

x = clicks
1.
2.

The four items were always administered in the above order. The order in which the words "faster," "slower," and "stays the same" were used was randomly varied with each item.

The purpose of the four different items is to assess what difference there is, if any, between perceptions of meter a) when the rhythms get "faster" (i.e. diminution) and b) when the rhythms get "slower" (i.e., augmentation), and what difference there is between perceptions of meter with c) duple rhythms (where the shift in rhythms is more pronounced, due to the proportions 1:2:8:16, but where the "beat" is also more obvious and regular), and d) hemiola rhythms (where the change is more gradual due to the proportions 2:3:4:6:8, but where the "beat" is less regular and more obscure). In other words, the intent of the different items is to assess whether the difficulty imposed by certain perceptual cues is more influenced by the gradualness of the changes or the regularity of beats in the changes.

Aural/Visual Task (COM AV)

For the purposes of this study, a conserver of meter is defined as a subject who answers correctly at least three of the four items on the Conservation of Meter Task. Any subject who is a nonconserver of meter on the aural/aural task (i.e., incorrectly answers two or more items) is given the aural/visual form of the task. This

serves as a check, in the event that the subject's failure on the aural/aural task is due, not to a lack of conservation, but to the inability to discriminate aurally between the clicks and the rhythms. The aural/visual form of the task is the same as the aural/aural form, except that the clicks are reinforced by the presence of a small blinking light, with one blink per click. A light mechanism is connected to the left channel of the tape recorder, and each click of meter powers a blink of light. Thus the subject both hears and sees an impulse representing meter. The procedure for this task is the same as that for the aural/aural task, except that the subject is asked to watch the blinks of light. The explanation is as follows:

> "Now you will see some blinks from this little light. (Demonstrate by turning on light.) Tell me if the blinks get faster or slower or stay the same. (Play Item 1, part A, blinks and clicks alone.) Did the blinks get faster or slower or stay the same? Now you will see the blinks and also hear some other sounds. Watch the blinks very carefully and tell me if they get faster or slower or stay the same. (Play Item 1, part B, blinks and clicks with rhythms.) (The same procedure for Items 2, 3, and 4, like that in the aural/aural task.)"

The reliability of the Conservation of Meter Task was established by applying the Kuder-Richardson formula (Tate, 1955, page 367). The reliability of the aural/aural form ranged from .77 to .79; that of the aural/visual form ranged from .58 to .76. (See Chapter Four.)

Conservation of Physical Properties: The Concept Assessment Kit--Conservation (CAK)

The Concept Assessment Kit--Conservation (Goldschmid and Bentler, 1968) was used to measure conservation of the following properties: two-dimensional space, number, substance, continuous quantity, weight, and discontinuous quantity. Form A was administered as the pretest, while Form B, a parallel form, was used as the posttest. (Use of Form C, a test of generalization to conservation of area and length, was omitted.) The tests of the Concept Assessment Kit--Conservation were administered according to the instructions in the manual, a procedure which consumes approximately 15 minutes. Responses were recorded on the forms provided, and scored as recommended in the manual (pages 5-6): correct judgments (behaviors) receive a score of 1, incorrect judgments, 0; correct explanations (those involving identity, compensation, and/or reversibility) receive a score of 1, incorrect explanations (perceptual, magical, etc.), receive 0. Forms A and B, then, each yield raw scores of 0 to 12 (one point each for judgment and explanation on each of six tasks). Percentile norms were provided for ages four to seven, but these were not used since the sample of the present study exceeded that age range. The authors report a reliability of .94 for Forms A and B (manual, page 11).

The Concept Assessment Kit--Conservation is reviewed in Buros' Seventh Mental Measurements Yearbook (1972) by J. Douglass Ayers, by Rheta DeVries and Lawrence Kohlberg, by Vernon C. Hall and Michael Mery, and by Charles D. Smock. The reviews range from favorable to cautionary, with controversy over the effects of a well-controlled, standardized procedure versus Piaget's more informal clinical method. While the limitations of the Concept Assessment Kit must be acknowledged, the kit adequately served the purpose of its role in the conservation of meter study. Any attempt to standardize Piaget's clinical interview method must necessarily entail, on the one hand, a compromise of strict Piagetian methods, and on the other, a compromise of complete standardization. It should be pointed out that at least one criticism of the kit does not apply to its use in this study, since the norms provided by the authors were not used as part of the data. In short, the Concept Assessment Kit provided for the present study an easily-administered measure of the major Piagetian areas of conservation, with appropriate materials and a standardized interview schedule.

Measure of Intellectual Maturity--The Draw-A-Man Task (DAM)

In order to obtain data on and control for individual differences in intellectual maturity, the Draw-A-Man Task (or more correctly, Draw-A-Person Task) was administered.

(Uniform I.Q. scores were not available from school records.) This task is an adaptation of the Goodenough Draw-A-Man Test, and its later revision, the Goodenough-Harris Drawing Test (Harris, 1963). The subject is given a sheet of plain white paper, 8 1/2 by 11 inches, a No. 2 pencil, and the following instructions (adapted from Harris, 1963, page 240):

> "I am going to ask you to draw a picture for me today. On this paper I want you to make a picture of a person. Make the very best picture that you can; take your time and work very carefully. Be sure to make the whole person, not just the head and the shoulders."

Harris (1963) cites studies in which the reliability of the Draw-A-Man technique was .89 by the split-half method, and ranged from .68 to .91 by test-retest methods. Evidence for the validity of the Goodenough Draw-A-Man test is cited by Harris (1963, pages 96-97) in the form of correlations with other I.Q. measures. Correlations with the Stanford Binet Test, for example, ranged from .41 to .65 for the I.Q. score and .26 to .92 for mental age; correlations with various subtests of the Wechsler Intelligence Scale for Children ranged from .05 to .77.

The drawings were scored by the experimenter according to the Point Scale outlined by Harris (1963, pages 248-292), which uses different scales for male and female figures in the drawings. The raw scores were converted to standard scores with a theoretical mean of 100 and a standard deviation of 15, according to Harris' tables of

norms (1963, pages 294-301). Harris (1963, page 294) indicates that the norms for four-year-olds were not based on samples as representative as those for other age groups and are, therefore, only offered as a "tentative guide" for use with preschool children. It should also be noted that these norms contain a bias toward underestimating a subject's standard score, as indicated by more recently reported data from the national Health Examination Survey of 1963-1965 (Harris, Roberts and Pinder, 1970), which also used the Draw-A-Person, rather than Draw-A-Man technique. The report, based on a collection of drawings of 7,068 children, states:

> Mean scores for children aged 6 to 11 years in the United States tended to be lower than those from the Harris norms consistently throughout the age range on the Man and Woman scales for both boys and girls. (page 10)

Thus, the Draw-A-Man scores in the present study likely reflect the bias of the Harris norms.

Training Procedures

All subjects who were nonconservers of meter on the pretest were randomly assigned to one of two groups: 1) training in conservation of meter, or 2) a control group (no training whatsoever). Training was administered by the experimenter to groups of four to five subjects of similar age (within a two year span), in periods of about 30 minutes.

The training was as follows:

1. Subjects observed an electric metronome set at MM = 80, which simultaneously emits clicks and blinks from a small light. They were asked to engage in large-muscle movements which correspond to the metronome impulses (moving "to the beat"), first clapping, then swinging arms, tapping one foot, and finally marching in a circle. The same was repeated with the metronome set at MM = 60 and MM = 120.
2. The subjects were then asked to listen to musical selections and duplicate the experimenter's movements in "follow the leader" style. When the music began, the experimenter clapped, tapped one foot, or marched to the beat of the music, and the subjects followed. Five musical examples were used, which had been chosen for their maintenance of a steady meter concurrent with obvious changes of rhythm. Each of the selections contained some type of rhythmic change involving either diminution or augmentation. Under the experimenter's direction, the subjects attempted to maintain their steady movements to the meter of the music, in spite of the rhythmic changes. The selections were prerecorded on tape and were taken from the record series for elementary schools Adventures in Music (RCA Records, 1970).

   The five selections were:

   1. J.S. Bach, Suite No. 2 in B minor: Rondeau

2. Gluck, "Armide" Ballet Suite: Musette
3. Grétry, (Arranged by Mottl), Céphale et Procris: Tambourin
4. Shostakovich, Ballet Suite No. 1: Petite Ballerina
5. Pierné, "Cydalise" Suite No. 1: Entrance of the Little Fauns

3. If any of the subjects were unable to maintain steady movements throughout the piece, the experimenter repeated the selection, and helped those subjects who were having difficulty by being in closer contact with them, saying "watch me" and "step, step, step, step" or "one, two, three, four," etc. Following each selection the experimenter posed these questions to the group:

> "Did our marching (or our feet or our arms, etc.) move the same all through the piece? Or did we get faster or slower? (We stayed the same.) And what about the music? Did the "beat" of the music change sometimes or did it stay the same? (The "beat stayed the same; the rhythms or "other notes" changed, got faster, slower, etc.)"

As much as was practicable, the experimenter continued in this fashion with each selection, teaching the subjects to make steady movements to music with rhythmic changes and afterwards reflecting on their movements and the music.

The training was designed to enhance the ability to conserve meter by having the subjects become aware of their own steady motor responses (clapping, marching, etc.) in the face of changes in rhythm. It was intended that this

experience promote cognitive conflict in subjects who would not assert the invariance of the "beat" (meter) by pointing out to them the fact that their own movements "went with the beat" and were remaining the same all through the piece.

Sampling Procedure and Subject Selection

The population of the present study was children (ages 4, 5, 7, and 9 years) of one day care center and two elementary schools (one of which included a preschool center) in Gainesville, Florida, who met the following conditions:

1. were of the Caucasian race,
2. had not at any time received private music instruction,
3. had the permission of their parent(s) or guardian(s) to participate in the study.

One of the elementary schools is part of a university laboratory school, which has a large population of children of university employees. The second elementary school was chosen to counterbalance this biasing effect, since the second school is in a different geographic area, and is believed to serve a different (generally lower) socioeconomic population.[1] The day care center was chosen on the basis of convenience and willingness to participate

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[1] However, no significant differences were found between the two elementary schools on any of the following measures: Conservation of Meter Task ($t = .16$; $df = 83$), Concept Assessment Kit--Conservation ($t = .15$; $df = 83$), and Draw-A-Man Task ($t = .22$; $df = 83$).

in the study. This center primarily serves the children of university students and is church-affiliated.

All of the 4-year-olds at the day care center who met the conditions outlined above were selected for the study. Also, all of the 4-, 5-, 7-, and 9-year-olds at the second school who met the conditions were selected. (School II contained a preschool center from which two 4-year-olds were drawn.) In the first school, however, 5-, 7-, and 9-year-old subjects who met the conditions were selected only from those classrooms (two at each grade level) that were assigned by the assistant director of the school to participate in the study.

The composition of the sample is presented in Table 1, which shows a total of 103 subjects at ages 4, 5, 7, and 9 years:

Table 1
Composition of Subject Sample

Age	Total No.	Males	Females	School	No.	School	No.
4 yrs.	18	11	7	Day Care	16	Sch. II-Pre	2
5 yrs.	42	24	18	Sch. I	21	Sch. II	21
7 yrs.	22	12	10	Sch. I	10	Sch. II	12
9 yrs.	21	12	9	Sch. I	10	Sch. II	11

The above table shows the complete sample, after a few subjects in each age group were lost due to absenteeism,

illness, etc. The age indications refer to one year ranges; i.e., "age 4" means 4 years, 0 months to 4 years, 11 months. The sample was intentionally selected to have more subjects at the 5-year-old level, since it was expected that this age group would provide important data on the nature of nonconservation and the effects of training.

Design of the Study

The design of the study is a "Pretest-Posttest Control Group Design" (Campbell & Stanley, 1963, page 13), which can be simply represented as:

R	O	X	O
R	O		O

where R indicates random assignment of subjects to two different groups, O indicates observations or measurements made, and X indicates treatment or training.

The steps that were followed in carrying out the design were:

I. Administration of Preliminary Vocabulary Test

All subjects were given the Preliminary Vocabulary Test. Any who did not answer all four items correctly were eliminated from the study and were replaced by other subjects of the same age and sex drawn from the pool of subjects available at that school

Subjects who passed the vocabulary test were immediately given the pretests. Subjects who did not pass the vocabulary

test and who were not retained in the study were given the first few items on each of the pretests so that, upon return to their classrooms, their experience with the experimenter was not different from that of their peers.

II. Administration of Pretests

All subjects who passed the Preliminary Vocabulary Tests were given:

a. Conservation of Meter Task--Aural/Aural.

All subjects who did not correctly answer at least three of the four items were given:

Conservation of Meter Task--Aural/Visual

b. Concept Assessment Kit--Conservation, Form A

c. Draw-A-Man Task.

All subjects who did not correctly answer at least three of the four items on either the aural/aural or the aural/visual Conservation of Meter Task were classified as "nonconservers of meter." There were 45 such subjects.

III. Administration of Training

All "nonconservers of meter" were randomly assigned to one of two groups:

a. those who received training (experimental group),

b. those who received no training (control group).

IV. Adminstration of Posttests

Following training (and after an interval of about one week), all subjects assigned to both the training and control groups were given:

a. Conservation of Meter Task--Aural/Aural, and, if necessary, Conservation of Meter Task--Aural/Visual,

b. Concept Assessment Kit--Conservation, Form B.

The posttests were the same as the pretests, except that Form B of the Concept Assessment Kit was used as the posttest.

Although the training dealt with conservation of meter, and not with the other Piagetian conservations, the posttests included a re-administration of the Concept Assessment Kit, in order to provide control over the effects of history. In the event that some subjects had achieved conservation and concrete operational thought in the interim between the pre and post testing, their scores on the Concept Assessment Kit would reflect this by being significantly higher on the posttest than they were on the pretest. Changes in score which indicated an advancement toward conservation and concrete operational thought on the posttest were statistically controlled in the analysis of the data. In addition, cross-modal transfer, had it occurred, would be evident, e.g., where training in conservation of meter had the effect of improving scores in conservation of space, number, or substance, etc..

The following is a list of possible confounding variables that were controlled by the subject selection and/or design of the study:

1. race (by subject selection),

2. level of previous music instruction (by subject selection),
3. level of vocabulary understanding (by administration of the Preliminary Vocabulary Test),
4. level of intellectual maturity (by administration of the Draw-A-Man Task),
5. level of ability in aural perception (by administration of the aural/visual form of the Conservation of Meter Task),
6. effects of maturation and history (both controlled by presence of control group; in addition, cognitive maturation of subjects was controlled by the posttest administration of the Concept Assessment Kit--Conservation).

Data Collection

All tests were administered individually (to one subject at a time) in a quiet room away from the normal classroom. The experimenter and three trained assistants (undergraduate students in Childhood Education) administered all tasks, using the same procedures by referring to carefully-written instruction sheets. Only two examiners administered tests at any given time; throughout the conduct of the study, however, the experimenter was aided by three different assistants. Training was administered only by the experimenter.

Within each school, no changes were made in the room, physical arrangements, or facilities and equipment used in testing. Complete data collection consumed approximately four to six weeks at each of the three sites.

CHAPTER FOUR
DATA ANALYSIS AND RESULTS OF THE STUDY

Analysis of data was accomplished in part through the use of subprograms from SPSS, Version 6.00 (Statistical Package for the Social Sciences, Nie et al., 1975). This chapter reports the results of the study, and is divided into three sections: 1) the reliability of the Conservation of Meter (COM) Task, 2) a summary of descriptive statistics, 3) presentation of data relevant to the questions of the study.

Reliability of the Conservation of Meter Task

The Kuder-Richardson formula (Tate, 1955, page 367) was used to provide an estimate of the reliability of the Conservation of Meter Task based on the number of items, variance of scores, and sum of item variances, according to the following formula:

$$r = \left(\frac{n}{n-1}\right)\left(\frac{\sigma^2 - \Sigma pq}{\sigma^2}\right)$$

where n = the number of task items, σ^2 = the variance of the scores, p = the proportion of subjects who answer a given item correctly, and q = 1 - p.

The estimated reliability of the Conservation of Meter Task--Aural/Aural (COM AA) ranged from .77 (based

on pretest data) to .79 (based on posttest data). The estimated reliability of the Conservation of Meter Task--Aural/Visual (COM AV) ranged from .58 (based on pretest data) to .76 (based on posttest data).

A possible explanation for the lower reliability of COM AV (based on pretest data) is that the COM AV task was only administered to those subjects who were low scorers on the aural/aural form of the task (COM AA)--i.e., those who scored less than three out of a possible total of four. Of the subjects who took the COM AV task, 71.4% continued to score low (below three) on the task; thus, the variance of scores for COM AV (1.727) is lower than that for COM AA (2.274), while the sum of item variances remained roughly the same (.973 for COM AV and .965 for COM AA). In the formula, a lower variance, other things being equal, results in a lower estimate of reliability. Given this subject selection factor in the administration of the COM AV task, and the fact that the task is only four items in length,[1] the obtained estimates showed that the COM task is sufficiently reliable.

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[1] Increasing the number of items on the task would have increased its reliability. Using the Spearman Brown Prophecy formula (Tate, 1955, page 334), the predicted reliability of the COM AV task would be increased from .58 to .73 if the number of items on the task were doubled, and other factors remained the same.

Summary of Descriptive Statistics

The following section presents summary tables of descriptive statistics on scores obtained on the Conservation of Meter Task (COM), the Concept Assessment Kit--Conservation (CAK), and the Draw-A-Man Task (DAM), as well as simple correlations between pairs of measures.

Conservation of Meter Task

As described previously, each subject was given the COM AA task. Those who achieved a score of three or four (out of four) were designated conservers of meter. Those who achieved a score of only zero, one, or two were given the aural/visual form of the task (COM AV). Likewise, those who obtained a score of three or four on the COM AV task were designated conservers of meter, while those who scored zero, one, or two were called nonconservers of meter. For the purposes of the data analysis, an "adjusted" or final COM score was used for each subject. The "adjusted" score for a subject who was given only COM AA (and who thus scored a three or four), was the COM AA score. The "adjusted" score for a subject who was given both the COM AA and COM AV (and who thus scored zero, one, or two on COM AA) was the COM AV score. These COM "adjusted" scores are, then, not statistically adjusted, but represent the last form of the task that was given.

To summarize, the following may be noted. The COM AA pretest was given to 103 subjects, of whom 56 scored as nonconservers. Of these 56 subjects, 11 scored as conservers on the aural/visual form of the task (COM AV). On the posttests, 45 subjects were given COM AA (post), of whom 38 scored as nonconservers. Of these 38 subjects, 9 scored as conservers when given the aural/visual form (COM AV). Thus a total of 20 subjects were able to improve their scores as a result of being given the aural/visual task. One explanation for this improvement is that the aural/visual form of the task controls for a possible weakness in aural discrimination on the part of the subject, and thus measures a conservation of meter schema that the subject indeed has, but is masked by difficulties with a purely aural task. This explanation conforms to the reasoning behind the use of the visual mode, as well as the aural mode, in the Conservation of Meter Task. However, other possible explanations are:

1. that presenting the task twice causes practice effects or the effects of learning, to improve performance on the second (COM AV) administration of the task;
2. that reinforcing the meter clicks with a visual stimulus structures the task in such a way as to make it more understandable (perhaps more concrete) to the subject;
3. that improvement on the aural/visual form of the task

is a result of the way in which different areas of the brain mediate stimuli of different modalities.

The adjusted COM scores, then, reflect the improvement that some of the subjects made on the second form of the task. Table 2 shows the means and standard deviations of adjusted COM scores for each age group. The means of COM scores increase at each age level. (Subjects at ages 5, 7, and 9 years were drawn from two schools. There was no significant difference between the total mean COM scores for School I and School II.) ($t = .16$; $df = 83$)

Table 2
Conservation of Meter Task Scores

Age Group	Mean	Std. Dev.	N
For entire population	2.6990	1.4131	103
4-year-olds--Preschool	1.722	1.406	18
5-year-olds--Kindergtn.	2.619	1.413	42
7-year-olds--Grade 2	2.909	1.411	22
9-year-olds--Grade 4	3.476	0.873	21

Table 3 presents the percentages of conservers of meter (based on adjusted COM scores) within each age level. There is an increase at each level, with 33% of the 4-year-olds and 76% of the 9-year-olds being conservers of meter.[1]

Table 3
Conservers of Meter
(Pretest Scores)

Age Group	No. of Conservers of Meter	Percent of Age Group Designated Conservers of Meter
4-year-olds	6	33.3
5-year-olds	27	64.3
7-year-olds	15	68.2
9-year-olds	16	76.2

[1] It should be noted that, for the purposes of this conserver/nonconserver classification, 5 subjects in the 4-year-old group and 1 subject in the 5-year-old group were classified as conservers of meter with considerable doubt and reservation. While these children did achieve criterion scores, they did so only with great difficulty, needing to have items repeated, taking guesses, changing their answers several times, and requiring the examiner to re-question them. Thus the figures above are exaggerated at the younger age levels; more strict scoring of the performance of these children would result in even fewer conservers of meter at the 4- and 5-year-old level.

Table 4 is a composite table of means and standard deviations of adjusted COM scores, showing, for each age group, a breakdown by school and sex. (Differences between age groups and sexes are discussed later.)

Table 4
Conservation of Meter Task Scores

Age Group	Mean	Std. Dev.	N
For entire population	2.6990	1.4131	103
4-year-olds--Preschool	1.722	1.406	18
Day Care	1.938	1.340	16
Male	1.700	1.418	10
Female	2.333	1.211	6
School II--Preschool	0.0	0.0	2
Male	0.0	0.0	1
Female	0.0	0.0	1
5-year-olds--Kindergtn.	2.619	1.413	42
School I	2.524	1.569	21
Male	2.733	1.438	15
Female	2.000	1.897	6
School II	2.714	1.271	21
Male	3.000	1.000	9
Female	2.500	1.446	12
7-year-olds--Grade 2	2.909	1.411	22
School I	2.400	1.350	10
Male	2.800	1.304	5
Female	2.000	1.414	5
School II	3.333	1.371	12
Male	4.000	0.0	7
Female	2.400	1.817	5
9-year-olds--Grade 4	3.476	0.873	21
School I	3.300	0.949	10
Male	3.600	0.894	5
Female	3.000	1.000	5
School II	3.636	0.809	11
Male	3.429	0.976	7
Female	4.000	0.0	4

Finally, Table 5 presents posttest data, showing the means and standard deviations of adjusted COM posttest scores for each age group, with a breakdown by school and treatment group (experimental or trained group and control or untrained group). (Differences between these groups are discussed later.)

Table 5
Conservation of Meter Posttest Scores

Age Group	Mean	Std. Dev.	N
For entire populations	2.0667	1.5869	45
4-year-olds--Preschool	1.824	1.667	17
Day care	1.800	1.740	15
Control	1.571	1.718	7
Experimental	2.000	1.852	8
School II--Preschool	2.000	1.414	2
Experimental	2.000	1.414	2
5-year-olds--Kindergtn.	2.353	1.455	17
School I	1.889	1.269	9
Control	1.000	0.816	4
Experimental	2.600	1.140	5
School II	2.875	1.553	8
Control	2.667	1.528	3
Experimental	3.000	1.732	5
7-year-olds--Grade 2	1.143	1.574	7
School I	1.200	1.789	5
Control	2.000	2.828	2
Experimental	0.667	1.155	3
School II	1.000	1.414	2
Control	2.000	0.0	1
Experimental	0.0	0.0	1
9-year-olds--Grade 4	3.500	0.577	4
School I	3.333	0.577	3
Control	3.500	0.707	2
Experimental	3.000	0.0	1
School II	4.000	0.0	1
Control	4.000	0.0	1

Concept Assessment Kit--Conservation

The Concept Assessment Kit--Conservation (CAK) is scored from 0 to 12, with one point each awarded for correct judgment and explanation on each of six Piagetian tasks: conservation of two-dimensional space, number, substance, continuous quantity, weight, and discontinuous quantity. Table 6 presents the means and standard deviations of these scores for each age group. There was an increase at each age level, as would be expected. (There was no significant difference between total mean CAK scores for School I and School II.) ($t = .15$; $df = 83$)

Table 6
Concept Assessment Kit Scores

Age Group	Mean	Std. Dev.	N
For entire population	6.2524	4.8481	103
4-year-olds--Preschool	1.556	2.526	18
5-year-olds--Kindergtn.	4.476	4.221	42
7-year-olds--Grade 2	8.364	3.849	22
9-year-olds--Grade 4	11.619	0.865	21

Draw-A-Man Task

Standard scores for the Draw-A-Man Task (DAM), as a measure of intellectual maturity, are based on norms reported by Harris (1969) which have a mean of 100 and a standard deviation of 15. Table 7 shows the means and

standard deviations of the Draw-A-Man scores for each age group in the present study. (There was no significant difference between total mean DAM scores for School I and School II.) ($t = .22$; $df = 83$)

Table 7
Draw-A-Man Task Standard Scores

Age Group	Mean	Std. Dev.	N
For entire population	96.8835	16.0314	103
4-year-olds--Preschool	88.000	13.647	18
5-year-olds--Kindergtn.	96.976	16.107	42
7-year-olds--Grade 2	101.136	15.204	22
9-year-olds--Grade 4	99.857	16.662	21

With the exception of the 4-year-olds, group means ranged from approximately 97 to 101, with standard deviations of approximately 16 to 17. This can be taken as an indication that the sample was representative in terms of intellectual maturity. The exception may have been the 4-year-old group, whose mean Draw-A-Man score was 88; however, Harris' tables of norms (1969, pages 294-301) explicitly state that the norms provided for 3- and 4-year-olds were not derived from representative samples and are offered only as a "tentative guide." Further, more recent research has indicated that Harris' norms for all age groups are not representative of U.S. children (Harris, 1970), and tend to result in low standard scores.

Correlations Between Measures

Simple correlations between pairs of measures were computed with the Pearson Product-Moment Correlation Coefficient. Mathematically this correlation is defined as (Tate, 1955, page 238):

$$r = \frac{\Sigma (X - \bar{X})(Y - \bar{Y})}{\sqrt{[\Sigma (X - \bar{X})^2][\Sigma (Y - \bar{Y})^2]}}$$

where X and Y are the two variables in question, $\bar{X}$ = the mean of X, and $\bar{Y}$ = the mean of Y.

Table 8 shows the correlation coefficients between pairs of variables, the levels of significance (for one-tailed tests), and the number of subjects on which the calculations were based.

Table 8
Correlations Between Measures

Variables	Pearson Corr. Coef.	Sig.	N
COM (adjusted) and CAK	.52	.001	103
COM AA and COM AV	.31	.009	56
DAM (standard) and CAK	.38	.001	103
DAM (standard) and COM (adjusted)	.28	.002	103

Of particular importance is the correlation of .52 between the measure of Piagetian conservation tasks (CAK) and the Conservation of Meter Task. The low but significant correlation between the aural/aural and aural/visual forms

of the COM task (.31) may be partly explained by the fact that some of the subjects (perhaps those whose COM AA score was low due to poor aural discrimination) had an increase in score on COM AV, presumably because of the addition of the visual stimulus to the task. A second factor in this low correlation may be the lower reliability of COM AV (.58) compared to that of COM AA (.77). Finally, it should be re-emphasized that, while both forms of the task purport to measure conservation of meter, they do so with differences in the sensory modalities used, and this too may be a factor in the low correlation between the two forms. Of particular interest also are the low but significant correlations between the Draw-A-Man task (standard scores) and both the Piagetian conservation tasks and the COM task. It is consistent with Piagetian theory to find no high correlation between conservation ability and an "intelligence" score.

The Questions of the Study

Below are listed each of the questions of the study, followed by the results of the data analysis.

Questions 1a and 2

Are scores on the Conservation of Meter Task related to age?

Are scores on the Conservation of Meter Task related to scores on conservation tasks involving physical properties (e.g., space, number, substance, etc.)?

Questions 1a and 2 were combined for the purposes of data analysis. The relationship between COM (adjusted) scores and the combined effects of age (in months) and CAK scores were investigated through multiple regression analysis (SPSS subprogram REGRESSION) with Draw-A-Man raw scores as an additional variable in the analysis. Table 9 presents the partial correlation coefficients for the variables in question:

Table 9
Partial Correlation Coefficients

	COM	Age	CAK	DAM (raw)
COM		.3766	.5235	.4039
Age		----	.7178	.7726
CAK		----	----	.6595
DAM (raw)				

It is apparent that both CAK and DAM are more highly correlated with COM than is age.

Table 10 summarizes the results of multiple regression analysis, using the standard regression strategy in which variables are entered in the order of correlation, and each variable is given credit only for its incremental contribution, after the effects of the previous variables have been assessed.

Table 10
Multiple Regression: COM with CAK, DAM, and Age

Variable	Multiple R	R Squared	RSQ Change	B	Beta
CAK	.52352	.27408	.27408	.14261	.48929
DAM (raw)	.52930	.28016	.00608	.02064	.15281
Age	.53194	.28296	.00280	-.00614	-.09270
(Constant)				1.89105	

These results showed that the combined effects of CAK score, DAM raw score, and age were related to COM by a multiple R of .53 which is significant at the .001 level (analysis of variance of the regression and residual factors yields F = 13.02 with df = 3, 99). Thus, CAK, DAM, and age together accounted for approximately 28.3% of the variance in COM scores ($R^2 = .53^2 = .28$). By itself, CAK score accounted for 27.4% of the variance in COM scores; adding both DAM score and age to this effect increased the amount of variance accounted for by only .9%, a negligible amount. This result is explained by the

fact that, even though DAM scores and the age variable had partial correlations with COM of .40 and .38, respectively, their high correlation with CAK scores (.66 and .72 respectively) allowed them to add only a minute contribution to the overall correlation. In other words, once adjustments were made in the DAM and age variables for the effects of CAK score, little remained that could be attributed solely to DAM scores or age.

Table 10 also gives regression coefficients for the prediction equation $Y' = B_1X_1 + B_2X_2 + B_3X_3 + A$, where

Y' = predicted COM scores

X_1 = CAK scores

X_2 = DAM raw scores

X_3 = age in months.

B_1, B_2, and B_3 are coefficients associated with X_1, X_2, and X_3 respectively, and A = a constant.

The resulting equation is:

Predicted COM = (.143 X CAK) + (.021 X DAM)
+ (-.006 X Age) + 1.891

(with standard error of estimate = 1.215).

The overall significance of this regression equation was .001 (analysis of variance of the regression and residual factors yields F = 13.02 with df = 3, 99). Further tests for the significance of the individual regression coefficients were made according to the following formula, using the standard regression approach (Nie et al., 1975, page 337):

$$F = \frac{R^2 \text{ change}/1 \text{ df}}{1 - R^2/(N^2 - k - 1) \text{ df}}$$

The results showed that the regression coefficient B_1 for CAK was significant at the .001 level (F = 36.99 with df = 3, 99), while the regression coefficient B_2 for DAM was not significant (F = .83 with df = 3,99), and the coefficient B_3 for age (and its negative sign) were also not significant (F = .42 with df = 3, 99). These latter two variables, DAM and age, can thus be ignored as predictors of COM when and only when CAK is used as a predictor.

It was concluded that, in answer to Questions 1a and 2, both CAK and age are positively related to COM. When the effects of CAK, DAM, and age are combined, they attain a multiple R of .53 and account for 28% of the variance, of which such a significant portion is due to CAK that the contributions of DAM scores and age are superfluous. These results support the hypotheses of the study that success on the COM task is related to age and that it is related to CAK scores.

The results obtained through multiple regression can be underscored by an additional analysis of the data that was made using analysis of variance procedures. Table 11 below summarizes the analysis of variance of COM adjusted scores by age group and CAK scores, using a hierarchal approach (SPSS subprogram ANOVA; option 10) in which the

sum of squares for the first variable, age group, is not adjusted for the variable CAK (but the variable CAK is adjusted for the effects of age group).

Table 11
Analysis of Variance of COM Scores

Source of Variation	Sum of Squares	df	Mean Square	F	Sig. of F
Main Effects	73.926	14	5.280	3.582	.001
Age Grp.	31.098	3	10.366	7.031	.001
CAK	42.828	11	3.893	2.641	.006
Residual	129.743	88	1.474		
Total	203.669	102	1.997		

These results showed that age group was significant at the .001 level, when the sum of squares was not adjusted for the effects of CAK, and CAK scores were significant at the .006 level, even when the sum of squares was adjusted for the effects of age group. Thus, with the hierarchal approach, age group was seen as significant. (This same result was also seen in the analysis of variance of COM scores by age group and sex for Question 1b. For the results of post hoc tests on the differences among means of each age group, see that section, page 80.)

However, an alternative analysis of variance procedure produced different results. Table 12 summarizes the

results of analysis of variance of COM scores by age group and CAK scores using the classic experimental approach (SPSS subprogram ANOVA; default option). With this approach, the sum of squares for each factor is adjusted for the effects of the other factor.

Table 12
Analysis of Variance of COM Scores

Source of Variation	Sum of Squares	df	Mean Square	F	Sig. of F
Main Effects	73.926	14	5.280	3.582	.001
Age Grp.	2.964	3	.988	.670	.999
CAK	42.828	11	3.893	2.641	.006
Residual	129.743	88	1.474		
Total	203.669	102	1.997		

Thus, the results showed that CAK was still significant at the .006 level, even after adjustments for age were made, but age group was not significant when its sum of squares was adjusted for the effects of CAK scores.

To summarize the results of the data analysis on this question, both age and performance on Piaget's conservation tasks (as measured by CAK) were significantly related to performance on the COM task; however, since age and CAK score were highly correlated, the latter variable was a stronger predictor, and the former variable was not

significant when and only when adjustments were made for the effects of CAK. These results were, nonetheless, taken as tentative support for the hypotheses of the study that success on the COM task is related to age and success on Piagetian conservation tasks.

The following section (Question 1b) pursues this issue further and shows that age group was significant when combined in the analysis with sex. This section also shows the results of the post hoc comparisons among the mean COM scores of each age group.

Question 1b

Is there a significant difference in mean scores on the Conservation of Meter Task among various age groups (4, 5, 7, and 9 years) or between sexes?

Table 13 summarizes the results of analysis of variance (SPSS subprogram ANOVA; classic experimental approach) of the adjusted COM scores by age group (4, 5, 7, and 9 years) and sex (male, female).

Table 13
Analysis of Variance of COM Scores

Source of Variation	Sum of Squares	df	Mean Square	F	Sig. of F
Main Effects	35.542	4	8.886	5.280	.001
Age Grp.	31.765	3	10.588	6.291	.001
Sex	4.445	1	4.445	2.641	.103
2-way interactions	8.245	3	2.748	1.633	.186
Group Sex	8.245	3	2.748	1.633	.186
Residual	159.882	95	1.683		
Total	203.669	102	1.997		

Age was significant at the .001 level, while sex and the sex-by-age group interaction were both nonsignificant. Differences among the COM task means for each age group were further tested using Duncan's New Multiple Range Test (Kirk, 1968, page 93). The formula for this test is:

$$W_r = q_r \; \alpha; r, \nu \sqrt{\frac{MS_{error}}{n}}$$

where W_r = the difference between two means that a comparison must exceed in order to be declared significant, q_r = a value obtained from Duncan's table (Kirk, 1968, page 533), MS_{error} = mean square error, and n = the number of subjects in each group. Since there was an unequal number of subjects in each age group, n in the above was replaced by a weighted average equal to $\frac{k}{\sum \frac{1}{n}}$

where k = the number of groups being compared (two).

Evidence supporting this procedure is given by Kramer (1956). Table 14 shows the mean COM score for each age group, and the differences between each pair of means. The figures in parentheses give the level at which the differences are significant (n.s. means not significant).

Table 14
Differences Among Mean COM Scores

Age Group		4 years	5 years	7 years	9 years
		1.722	2.619	2.909	3.476
4 years	1.722		.897(.05)	1.187(.01)	1.754(.01)
5 years	2.619			.290(n.s.)	.857(.05)
7 years	2.909				.567(n.s.)
9 years	3.476				

These results show that the differences in mean COM scores were all in the expected direction--i.e., in general older subjects had significantly higher mean scores than younger ones. The exceptions occurred in the differences between 5- and 7-year-olds and between 7- and 9-year-olds, which were not significant (although the difference between 5- and 9-year-olds was significant).

Question 3

Is improvement in performance on the Conservation of Meter Task resistant to training for preoperational subjects? Specifically, is there a significant difference in mean scores on the Conservation of Meter posttest between trained and untrained subjects, at the preoperational (or concrete operational) level?

Table 15 summarizes the results of analysis of variance (SPSS subprogram ANOVA; classic experimental approach and covariates processed prior to factors) of COM posttest scores by treatment group (trained and untrained subjects) and level of CAK conservation score (preoperational subjects with a CAK score of three or less and concrete operational subjects with a score of six or higher).[1] Analysis of covariance was added to the procedure to provide adjustments for possibly confounding variables:

1. changes in developmental level during the pre-to-post test interim (indicated by pre-to-post test changes, if any, in CAK score),
2. intellectual maturity (Draw-A-Man standard scores),
3. pretest scores on the COM AA task.[2]

(Of these covariates, only the COM AA variable achieved significance.)

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[1] An initial attempt to partition posttested subjects into three levels of conservation score--preoperational, transitional, and concrete operational--failed because the resulting cell sizes were too small.

[2] The aural/aural rather than aural/visual form of the COM task was used as a covariate because of its higher estimated reliability.

Table 15
Analysis of Variance of COM Posttest Scores

Source of Variation	Sum of Squares	df	Mean Square	F	Sig. of F
Covariates	15.521	3	5.174	2.905	.048
Change	.088	1	.088	.050	.999
DAM Stand.	2.184	1	2.184	1.226	.276
COM AA Pre.	14.079	1	14.079	7.905	.008
Main Effects	13.699	2	6.849	3.846	.031
Level	13.678	1	13.678	7.680	.009
Treatment	1.004	1	1.004	.564	.999
2-way interactions	5.981	1	5.981	3.358	.073
Level Trtmnt	5.981	1	5.981	3.358	.073
Residual	58.773	33	1.781		
Total	93.975	39	2.410		

The results showed that there was no significant difference between the mean COM posttest scores of trained and untrained subjects. There was, however, a significant difference between the COM posttest scores of preoperational and concrete operational subjects (as measured by CAK). Preoperational subjects (CAK = 3 or less) had a mean COM score of 1.88, while concrete operational subjects (CAK = 6 or more) had a mean of 2.62, with the difference significant at the .009 level. (Both of these means were below the level specified for "conservation of meter," i.e., COM equal to three or four.)

The level-by-treatment interaction was not significant, except at the .073 level, which almost approaches significance. Theoretically, this interaction would be expected to yield significance to the effect that trained, concrete operational subjects achieve the highest mean score on the COM posttest. This expectation was not supported, but should be re-investigated, since a possible reason for the lack of significance may be the small cell sizes that result from testing interactions. Perhaps a larger sample would produce a result different from this one.

These results support the third hypothesis of the study. Improvement in performance on the COM task is apparently resistant to training, for both preoperational and concrete operational subjects. In addition, the result that concrete operational subjects achieve higher COM scores than their preoperational counterparts is consistent with the hypothesis that conservation of meter is related to conservation of physical properties (as measured by CAK).

Questions 4, 5, and 6 involve pretest frequency data on the items of the Conservation of Meter Task. All three questions were answered by applying chi squared analysis to the data. The formula for chi squared is (Tate, 1955, page 263):

$$X^2 = \sum \frac{(f_o - f_t)^2}{f_t}$$

where f_o = observed frequencies, f_t = expected frequencies, and X^2 is referred to a table of the sampling distribution of this statistic (Tate, 1955, page 561).

Question 4

If a Conservation of Meter Task item is incorrectly answered, is the erroneous response to an item involving diminution more likely to be "faster"? Is the erroneous response to an item involving augmentation more likely to be "slower"? Specifically, is there a significant difference between the number of "faster" and "slower" responses among the incorrect responses given on each of the Conservation of Meter Task items?

Table 16 presents, for each item on the COM task, a breakdown of the incorrect responses into "faster" and "slower" responses, and the level at which differences are significant.

Table 16
Incorrect Responses to COM Task Items

Item	Type Rhythm	No. Faster Responses	No. Slower Responses	Sig.
Conservation of Meter Task--Aural/Aural				
1	diminution	18	18	n.s.
2	augmentation	9	30	.01
3	diminution	22	17	n.s.
4	augmentation	11	23	.05
Conservation of Meter Task--Aural/Visual				
1	diminution	20	6	.01
2	augmentation	18	15	n.s.
3	diminution	24	5	.01
4	augmentation	12	19	n.s.

Significant differences, when they occurred, were all in the expected direction; that is, rhythms in diminution promoted an incorrect response of "faster" (since the rhythms are getting "faster"), and rhythms in augmentation promoted an incorrect response of "slower." While significant differences are, in fact, in the expected direction, there is no ready explanation for why, on the aural/aural form of the task, these expectations were borne out on the items involving augmentation but not on those involving diminution, while on the aural/visual form of the task, the reverse is true. (This result may be described as an item-by-modality interaction.) Since each of the diminution items and each of the augmentation items utilize rhythms in both duple and hemiola proportions, the rhythmic relationships used in the items are apparently not a factor. It may be concluded that the results are equivocal, and warrant further investigation of this question. In the meantime, it is only possible to speculate on the reasons for these results. One very tentative hypothesis for this item-by-modality interaction may be that items involving rhythms in augmentation are more likely to be erroneously perceived as "slower" (instead of "staying the same") because the subject's attention is immediately attracted to the very fast, dense sounds at the beginning of the item. (It should be recalled that augmented rhythms gradually

get "slower" after a measure of very fast notes.) In other words, augmentation items, more so than diminution items, might be more likely to draw the subject's focus to the rhythms, and thus cause the subject to give the response of "slower." This effect, which results from the initial presentation in augmentation items of a flurry of fast, dense notes, may operate differently on the aural/aural and aural/visual forms of the task. Perhaps the effect has strength only in the completely aural presentation because in the aural/visual presentation, the visual stimulus (blinking light) has the higher priority of the subject's attention.

To summarize, further investigation might be devoted to how the subject's initial attention is differentially attracted to rhythms in augmentation and diminution, and how this effect might be altered when a competing stimulus (blinks of light) is presented.

Question 5

Are Conservation of Meter Task items involving duple rhythms more difficult than those involving hemiola rhythms? Specifically, is there a significant difference between the number of subjects who correctly answer Conservation of Meter Task items involving duple rhythms and those involving hemiola rhythms?

Table 17 shows the number of subjects who correctly answered the duple items (Items 1 and 2) and hemiola items (Items 3 and 4) on the Conservation of Meter Task.

Table 17
Duple and Hemiola Items on the COM Task

	Duple Items		Hemiola Items	
	1	2	3	4
COM AA N = 103	62	59	59	64
	(total: 121)		(total: 123)	
COM AV N = 56	28	21	25	23
	(total: 49)		(total: 48)	

There was no significant difference between the number of subjects who correctly answered the hemiola items and the number of subjects who correctly answered the duple items. It may be concluded that both types of items are of equal difficulty.

Question 6

Are Conservation of Meter Task items involving rhythms in diminution more difficult than those involving rhythms in augmentation? Specifically, is there a significant difference between the number of subjects who correctly answer Conservation of Meter Task items involving rhythms in diminution and those involving rhythms in augmentation?

Table 18 presents the number of subjects who correctly responded to COM items involving diminution (Items 1 and 3) and those involving augmentation (Items 2 and 4).

Table 18
Diminution and Augmentation Items on the COM Task

	Diminution Items		Augmentation Items	
	1	3	2	4
COM AA N = 103	62 (total: 121)	59	59 (total: 123)	64
COM AV N = 56	28 (total: 53)	25	21 (total: 44)	23

There was no significant difference between the number of subjects who correctly answered items involving rhythmic diminution and those who correctly answered items involving rhythmic augmentation. It may be concluded that both types of items are of equal difficulty.

Question 7

For what age group(s) or sex(es), if any, does training improve performance on the Conservation of Meter Task? Specifically, is there a significant difference in the mean scores on the Conservation of Meter posttest between the trained and untrained subjects, at various age levels (4, 5, 7, and 9 years) and for each sex (male, female)?

Table 19 summarizes the results of analysis of variance (SPSS subprogram ANOVA; default option with classic experimental approach and covariates processed prior to factors) of COM posttest scores by treatment group (trained and untrained), sex (male, female), and age group (4, 5, 7, and 9 years). Analysis of covariance provided adjustment for possibly confounding variables:

1. changes in developmental level (pre-to-post test

changes in CAK score),

2. intellectual maturity (Draw-A-Man standard scores),

3. pretest scores on the COM AA task.

Only one of the covariates, COM AA pretest score, achieved significance (.03 level).

Table 19
Analysis of Variance of COM Posttest Scores

Source of Variation	Sum of Squares	df	Mean Square	F	Sig. of F
Covariates	15.172	3	5.057	1.990	.138
Change	.103	1	.103	.040	.999
DAM Stand.	3.403	1	3.403	1.339	.256
COM AA Pre.	12.792	1	12.792	5.035	.031
Main Effects	13.600	5	2.720	1.071	.399
Group	12.002	3	4.001	1.575	.218
Sex	.524	1	.524	.206	.999
Treatmnt.	.054	1	.054	.021	.999
2-way interactions	11.366	7	1.624	.639	.999
Grp. Sex	.287	3	.096	.038	.999
Grp. Trtmnt.	9.298	3	3.099	1.220	.321
Sex Trtmnt.	1.671	1	1.671	.658	.999
3-way interactions	2.061	2	1.030	.405	.999
Grp Sex Tmt.	2.061	2	1.030	.405	.999
Residual	68.601	27	2.541		
Total	110.800	44	2.518		

The results showed that none of the main effects--age group, sex, or treatment--were significant. In addition, none of the interaction effects were significant. Two of the main effects--sex and treatment--were predictably nonsignificant; the fact that age group, however, was also not significant is at first glance a surprising result, given the fact that level of CAK score has previously been shown to be a significant main effect, and CAK and age are highly correlated. A possible explanation for this result lies in the design of the analysis, which called for dividing the subjects into their four age groups. This procedure results in small cell sizes, expecially at the upper age levels where nonconservers of meter were less numerous, and therefore makes statistical significance of the age group factor less likely. It should be recalled that in the analysis for Question 3, where level of CAK score was one of the main effects, subjects were divided into only two groups--preoperational and concrete operational levels. It should also be recalled that in the analysis for Questions 1a and 2, CAK score was shown to be a better predictor of COM score than was age. With these qualifications, then, age group in this analysis of COM posttest scores was not significant. With regard to the interactions, theoretical predictions would call for a significant age-by-treatment interaction in favor of older, trained subjects. The

results showed that this expectation was not supported, but this too is possibly explained by the cell sizes that resulted, especially at the upper age levels.

In summary, while age group and age-by-treatment interaction were not shown to be significant in this analysis, these two effects were the only two (of the main and interaction effects) that even yielded a computable F ratio. The question therefore warrants further investigation, with larger cell sizes, particularly at the upper age levels.

CHAPTER FIVE
SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

The purpose of this study was to develop and validate a measure of conservation of meter that represents an analogue to Piaget's conservation tasks involving physical properties such as space, number, substance, etc. The assumption of the study was that the Conservation of Meter Task could tentatively be considered a valid measure of the construct in question if the following hypotheses were supported:

1. Success on the task is positively related to age.
2. Success on the task is positively related to success on conservation tasks involving physical properties (e.g., space, number, substance, etc.).
3. Improvement in performance on the task is resistant to training for children at the preoperational level.

All three of these hypotheses were supported, with qualifications. In the section that follows, conclusions are drawn relevant to each hypothesis and question of the study.

Conclusions

Hypotheses 1 and 2 (Questions 1 and 2)

Analysis of variance methods indicated that age was a significant factor in performance on the COM task. In addition, regression analysis indicated that the combined effects of CAK, DAM, and age achieved a multiple R of .53 with COM scores, and accounted for about 28% of their variance. These results were highly significant (at the .001 level). The 72% of the variance that is not accounted for remains in question; it is apparently not due to race or private music instruction, which were experimentally controlled, or to intellectual maturity, since adding DAM scores to the analysis did not significantly diminish the amount of variance accounted for. Several other factors may have been operating, such as those due to measurement error (it should be recalled that the reliability of COM AA was .77 and of COM AV, .58), or to individual differences and abilities that were not controlled in the study (e.g., concentration and attention span or verbal comprehension that was not controlled by the Preliminary Vocabulary Test), or to aural musical abilities that may not have been controlled in the study. The contributions, if any, that might be made by these and other factors must be investigated. For the present, hypotheses 1 and 2 are tentatively supported because a

significant relationship was found between COM scores and the combined effects of CAK and age (with DAM). This allows for a tentative application of the stage concept to the development of conservation of meter. Age 4 can roughly be seen as a period of nonconservation. (Here only 33% of the subjects were conservers.) The ages of 5 to 7 years can be seen as a transitional stage, with there being no significant difference between these two age groups. By age 9, however, there is evidence of a final stage of conservation. (Here 76% of the subjects were conservers.) As such, conservation of meter represents a horizontal decalage within the period of concrete operations. That is, conservation of meter appears to develop somewhat later than other conservation abilities, such as conservation of number and substance.

Hypothesis 3 (Questions 3 and 7)

The results of analysis of variance of COM posttest scores indicated that training was not a significant factor in improving performance on the COM Task, for any age group or for any level of development (as measured by CAK). This result supports the hypothesis that improvement in COM performance is resistant to training for subjects at the preoperational level. However, it was expected that training, particularly that which, consistent with Piaget's theory, involves a type of cognitive conflict,

would have improved scores for subjects in the older age groups and at a higher level of cognitive functioning (as measured by CAK). Instead, interactions between treatment and, separately, age and CAK level were not significant (although CAK level alone, as a main effect, was highly significant). This result is possibly explained by the smaller cell sizes at the upper age level; it should be recalled that the subject sample was intentionally designed with a disproportionately larger number of subjects in the 4- and 5-year-old groups. Thus, while the question of the significance of training at upper levels must be further investigated, the present results support the hypothesis regarding the inefficacy of training preoperational subjects. These results contradict the study cited earlier by Botvin (1974), in which training was found to be significant; however, it must be pointed out that 1) Botvin's training involved entirely different methods than those used here, and 2) the task in question was one of conservation of melody, not of meter, and its validity had not been substantiated.

The remaining questions of the study (Questions 4, 5, and 6) concerned the different perceptual cues provided by the different items on the COM task.

With qualifications, there is tentative evidence that perceptual centration and a lack of the awareness of compensation are responsible for incorrect responses on

the COM task. Items involving rhythmic augmentation tend to be answered incorrectly with the response "slower" (at least on the aural/aural form of the task). Items involving rhythmic diminution tend to be answered incorrectly with the response "faster" (at least on the aural/visual form of the task). These results were very tentative, since no explanation is apparent for why the two forms of the task differ on the nature of the errors made. Further investigation is needed. In the meantime, the nature of the errors would tentatively suggest that nonconservers of meter frequently respond incorrectly because their perception centers on the variable rhythms (whether "faster" or "slower") and ignores the invariance of the meter clicks or blinks. Alternatively (but less likely) a nonconserving subject may perhaps center his perceptions on the meter and answer with a response that falsely describes the meter relative to the rhythms. For example, if a nonconserver perceives rhythms in diminution as "faster," he may respond to the item by answering "slower"--meaning "the meter clicks are slower than the (fast) rhythms," instead of answering that the clicks "stay the same." Perhaps this is analogous to the two types of nonconserving responses to Piaget's conservation tasks, which result from centration on one or the other dimensions of a display; for example 1) asserting that a glass has more water than a cylinder because it is wider, or 2) asserting that the glass has less because it is shorter.

Perceptual centration on the COM task may be related to a lack of compensation. That is, the nonconserving subject does not assert that the meter clicks (or blinks) stay the same because he does not perceive that augmentation, while it involves steadily fewer notes, also involves increasingly longer durations, and that diminution involves more, but shorter, notes.

Perceptual centration and a lack of compensation may be retained as plausible explanations for the errors made on the COM task. To some extent, this is supported by the results of Question 4, which indicated that on some items, errors were significantly made in the expected direction ("faster" on diminution items; "slower" on augmentation items); however, this question awaits further investigation.

Questions 5 and 6 were concerned with the relative difficulty of items on the COM task. The results showed that there was no significant difference in difficulty between duple and hemiola items, or between augmentation and diminution items. The latter result indicated that the difficulty of an item was not affected by whether there was an obvious, regular beat (as in duple rhythms) or whether there was an irregular beat with subtle and gradual changes (as in hemiola rhythms).

It may be tentatively concluded from the results of this study that conservation of meter is a legitimate

construct, consistent with Piaget's theory, and that the Conservation of Meter Task is valid measure of the construct. Evidence has been given which shows that, while conservation of meter may, on the surface, seem to be quite obvious and natural (especially to musicians) it may in fact be a developmental ability that evolves slowly over a period of time. These conclusions are made with qualifications which have already been discussed. There were, in addition, some weaknesses in the study which should be remedied in future research. The following should especially be noted:

1. The aural/visual form of the task may not have provided complete control over the variable of aural discrimination because, although this form of the task has face validity with regard to the control intended, this was not tested. Administration of an instrument which measures aural discrimination would be helpful.
2. The problem of vocabulary (which is crucial in conservation tasks) may not have been entirely controlled by administration of the Preliminary Vocabulary Test. While all subjects passed this screening (or were eliminated from the study), by answering all items correctly, the reliability and validity of the test was not established prior to its use in the study.
3. Items on all the conservation tasks--in both COM and CAK--were presented in the same order, and the possible influences of order effects were not investigated.

4. In addition, performance on the COM AV task may have been influenced by possible effects of practice and learning which result from the prior administration of the COM AA task. These possible effects were not controlled.
5. The experimenter was aided by assistants in the administration of the tasks, and while the assistants were thoroughly trained, inter-examiner reliability was not tested.
6. The training used in this study was of a general nature, lasting only a single session. It is possible that other training, specific to the task, over a longer period of time, would produce different results.

Further research should attempt to remedy the weaknesses mentioned above. In addition, the following recommendations are made:

Recommendations for Further Research

1. Additional variables which may account for variance in COM scores across different groups should be identified.
2. Further investigation is needed of the item-by-modality interaction as it affects the nature of incorrect responses ("faster" and "slower") to COM task items.
3. The effects of various types of training in conservation of meter, including general and specific, and short and long-term training, should be investigated.
4. Applications of the concept of conservation of meter should be made to tasks which use "real" music--i.e.,

contain the other variables such as pitch, loudness, harmony, etc.

5. The effects of different types of rhythmic patterns should be studied.
6. The effects of different types of meters (both regular and irregular, of various groupings) should be assessed.
7. The effects of different home environments and different school music programs on conservation of meter should be investigated.
8. The effects of different modalities (aural and visual) on the Conservation of Meter Task should be studied further.
9. Research on the development of conservation of meter should be replicated cross-culturally.
10. Conservation of meter should be further investigated to see if it has relevance outside the field of music--in poetry, for example.
11. Additional music conservation tasks (e.g., conservation of melody, rhythm, etc.) should be validated.

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BIOGRAPHICAL SKETCH

Mary Louise Serafine was born in Rochester, New York on July 2, 1948. She attended public schools in Webster, New York before entering Douglass College of Rutgers University in 1966. At Rutgers, Ms. Serafine majored in music, studying piano under Thomas Richner and harpsichord under James R. Wilson.

Ms. Serafine received an M.Ed. degree from the University of Florida in 1971, with a major in curriculum and instruction and a specialization in music history and literature. It was during this time that she completed research for a volume of harpsichord works entitled Baldasarre Galuppi: Six Keyboard Sonatas (Carl Fischer, Inc.).

She began advanced study for a Ph.D. degree at the same institution in 1971, and developed an interest in Piaget's theory through work in the Childhood Education Department. This study is an outgrowth of her interests in music and psychology.

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

William D. Hedges, Chairman
Professor of Education

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Jacquelin R. Goldman
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I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

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